



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Thakur et al.

Serial No.: 09/654,093

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For: A METHOD TO AVOID THRESHOLD
VOLTAGE SHIFT IN THICKER DIELECTRIC FILMS

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§ Examiner: P. Brock II
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§ Atty. Docket: 94-0302.02
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APPLICANTS' SECOND BRIEF ON APPEAL

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APPLICANTS' BRIEF ON APPEAL

I. REAL PARTY IN INTEREST

The Applicants, Randhir Thakur, Ravi Iyer, and Howard Rhodes, have assigned their interest in this application to Micron Technology, Inc.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to the Applicants or the assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF THE CLAIMS

Claims 1-64 have been presented during prosecution of the application under appeal.

Claims 1-51 have been canceled.

Claims 52-64 are pending.

Claims 52-64 are rejected.

Claims 52-64 are appealed.

IV. STATUS OF THE AMENDMENTS

Applicants filed no amendments subsequent to final rejection.

V. SUMMARY OF THE INVENTION

The current invention addresses methods to avoid threshold voltage shift in a dielectric. One exemplary embodiment is directed to a method of processing a semiconductor device. The method comprising: depositing a dielectric layer (FIG. 3, element 20) over a semiconductor substrate (FIG. 3, element 18; *see also* Specification at p. 8, ln. 23-p. 9, ln. 1), the substrate

comprising a plurality of electrically conductive regions (FIG. 3, elements 12) and an electrically insulative region therebetween (FIG. 3, element 14; see also Specification at p. 8, ln. 30-31); allowing electrically chargeable particles (FIG. 3, elements 24) to occur in the dielectric layer (Specification at p. 7, ln. 30 – p. 8, ln. 1); allowing some diffusion of the electrically chargeable particles (*id.* at p. 9, ln. 12-13); and preventing at least some of the electrically chargeable particles from reaching the substrate (*id.* at ln. 19-21). In a more specific embodiment of this type, the act of depositing a dielectric layer comprises using an organic precursor (*id.* at p. 7, ln. 16-18; p. 8, ln. 14-15); the act of allowing electrically chargeable particles to occur comprises allowing an organic component of the organic precursor to deposit in the dielectric layer (*id.* at p. 7, ln. 23-30); and the act of preventing comprises layering a barrier (FIG. 3, element 30) over the substrate using a non-organic precursor prior to the act of depositing a dielectric layer (*id.* at p. 8, ln. 28-31; p. 9, ln. 24-33).

Another exemplary embodiment within the scope of the current invention is directed to a method of processing a substrate comprising two active areas and an intervening insulating region. The method comprises: depositing an oxide charge barrier over the substrate (Specification at p. 8, ln. 28-31; FIG. 3, element 30); depositing a generally insulative material over the oxide charge barrier (*id.* at p. 5, ln. 24-25 (listing as non-limiting examples BPSG, BSG, PSG, and silicon dioxide); p. 8, ln. 28-31; FIG. 3, element 20), wherein the generally insulative material is less insulative than the barrier (*compare id.* at p. 5, ln. 24-25; p. 7, ln. 16-p. 8, ln. 4 (discussing exemplary dielectric materials with oxide charges therein) *with* p. 9, ln. 24-p. 10, ln. 32 (discussing exemplary barrier materials and methods of formation)); and providing a generally conductive element (FIG. 3, element 26) over the generally insulative material (FIG. 3; element 20; *see also* Specification at p. 5, ln. 25-28), wherein the element is generally laterally coextensive with the intervening insulating region (*id.* at p. 5, ln. 25-30; *compare* FIG. 3, element 26 *with* FIG. 3; element 14).

Still another exemplary embodiment within the scope of the current invention is directed to a method of at least partially forming a circuit device, comprising: providing a semiconductor substrate (Specification at p. 5, ln. 10; FIG. 3, element 18); layering a carbon-free barrier on the substrate (*id.* at p. 9, ln. 24-33; FIG. 3, element 30); and layering a carbon-containing dielectric on the barrier (*id.* at p. 7, ln. 1-15; p. 8, ln. 14-22; FIG. 3, element 20).

VI. ISSUES

There are six issues for determination on appeal:

1) whether one of ordinary skill in the art is reasonably apprised under 35 U.S.C. §112 of the scope of claim 60;

2) whether the Examiner has failed to meet the burden for rejection under 35 U.S.C. §103 based on a combination of Doan and Boland;

3) whether the Examiner has failed to meet the burden for rejection under 35 U.S.C. §103 based on a combination of Doan and Cunningham;

4) whether the Examiner has failed to meet the burden for rejection under 35 U.S.C. §103 based on a combination of Doan, Cunningham, and Ying;

5) whether the Examiner has failed to meet the burden for rejection under 35 U.S.C. §103 based on a combination of Doan and Ghezzi; and

6) whether the Examiner has failed to meet the burden for rejection under 35 U.S.C. §103 based on a combination of Doan, Ghezzi, and Van Der Scheer.

VII. GROUPING

Applicants define the following groups of claims for consideration upon this appeal. These groups correspond to the issues listed above.

Group I: claim 60;

Group II: claim 52;

Group III: claims 53-57;

Group IV: claims 58-59;

Group V: claims 60-61 and 63-64 (the claims do not necessarily fall together);

and

Group VI: claim 62.

VIII. ARGUMENT

The Examiner's Final Office Action is directed to rejections based on 35 U.S.C. §§ 112 and 103. Applicants address the rejections separately below.

A. One of ordinary skill in the art is reasonably apprised under 35 U.S.C. §112 of the scope of claim 60.

Claim 60 refers to a “generally insulative material” and a “generally conductive element” that is “generally laterally coextensive” with an insulating region. In the latest Final Office Action, the Examiner argued that the term “generally” lacks support in the Specification and that one of ordinary skill in the art would not be reasonably apprised of the scope of the invention given that term. As a result, the Examiner found the claim to be indefinite. The Examiner's text addressing this rejection appears to have been lifted verbatim from previous Office Actions. (*Compare* Office Action dated 8/21/02 at p. 3, ¶#3 *with* Office Action dated 2/1/02 at p. 2, ¶#2 *and* Office Action dated 9/4/01 at p. 2, ¶#2.)

1. Applicants' previous arguments and the Examiner's previous admission support definiteness

Accordingly, Applicants have already presented counter arguments in the Amendment and Response to the Office Action dated 9/4/01. Applicants submit that those counter arguments still apply and refute the Examiner's rejection. In order to avoid unnecessary redundancy, Applicants will not repeat those counter arguments here, although a copy of the Amendment and Response is included in an appendix for the Board's convenience. In summary, Applicants pointed out support in the Specification for those terms and provided relevant dictionary definitions, which indicate the ability of one of ordinary skill in the art to ascertain the requisite degree indicated by the term “generally.” (Amendment and Response at p. 2-4.)

The Examiner subsequently admitted that the Specification provides examples of insulative, conductive, and laterally coextensive elements. (Office Action dated 2/1/02 at p. 8, ¶#11.) Nevertheless, the Examiner announced a refusal to assume that the claim's limitations,

which include the qualification “generally,” are the same as the Specification’s supporting text. (*Id.*)

Applicants agree that the claim’s limitations are not the exact same as the Specification’s examples and in fact expressed so by referring to those examples as “non-limiting.” (Amendment and Response at p. 3.) However, Applicants contend that the Specification’s myriad examples alert one of ordinary skill in the art that there is no one particular/bright-line/absolute threshold magnitude for conductivity, insulativeness, or lateral extensivity. Applicants further contend that the dictionary definitions previously provided indicate that one of ordinary skill in the art would already be aware of that -- and would understand that there is inherent uncertainty in such qualities at some level of scrutiny -- even before reading the Specification. (Applicants also note that the Examiner failed to address those dictionary definitions.) Hence, one of ordinary skill in the art, being deemed by law to be aware of the dictionary definitions provided and therefore accepting of their inherent uncertainty, would understand what is claimed given that background knowledge and the non-limiting yet supporting examples in the Specification.

2. Case precedent supports definiteness

The applicable law referred to above can be found in case precedent, which holds that the test for definiteness is whether one of ordinary skill in the art would understand the bounds of the claim. (*Miles Laboratories Inc. v. Shandon Inc.*, 997 F.2d 870, 875, 27 U.S.P.Q.2d 1123, 1126 (Fed. Cir. 1993), *cert. denied*, 510 U.S. 1100 (1994). This and all other cases cited herein are included in appendices to this Second Appeal Brief.) This precedent further details that, if one of ordinary skill in the art would be reasonably apprised of the invention’s scope, §112 ¶2 demands no more. (*Id.*) As to whether such an artisan would be so apprised, case precedent stresses that the specification plays a part in guiding one of ordinary skill in the art. (*Id.*; *see also Orthokinetics Inc. v. Safety Travel Chairs Inc.*, 806 F.2d 1565, 1575, 1 U.S.P.Q.2d 1081, 1088 (Fed. Cir. 1986).) Per the Applicants’ previous arguments and the Examiner’s previous admission (both addressed in the paragraphs above), the current Specification provides such guidance.

a) Pertinent prior art supports definiteness

Another factor indicating that the ordinary artisan would be reasonably apprised of the invention's scope is the knowledge imparted by the pertinent prior art. (*In re Carlson*, 983 F.2d 1032, 1038, 25 U.S.P.Q.2d 1207, 1211 (Fed. Cir. 1992); *Chemical Separation Technology Inc. v. United States*, 51 Fed. Cl. 771, 782, 63 U.S.P.Q.2d 1114, 1123 (Fed. Cl. 2002).) In addition to knowing the dictionary definitions addressed above, one of ordinary skill in the art would also be familiar with the specific terms at issue. Concerning the phrase “generally laterally coextensive,” Applicants submit that one of ordinary skill in *any* art, including the one at issue on appeal, would understand the term. This is true given the wide range fields in which the term has been used since before the priority date of the application on appeal. U.S. Pat. No. 5,041,809 by Payne, for example, uses the term “generally laterally coextensive” in claims 1 and 12 to relate two conductive elements on a substrate. (This and all other references cited herein are included in appendices to this Second Appeal Brief.) Payne further discusses lateral coextensivity in general at col. 3, ln. 50-53; col. 4, ln. 26-35; and illustrates general lateral coextensivity in FIGS. 2A and 2B. U.S. Pat. No. 4,767,586 by Radwanski uses the term “generally laterally coextensive” in claim 16 in relating two slots of a housing that manufactures a fibrous web. Radwanski specifically discusses that term in its Abstract and at col. 8, ln. 4-5; col. 9, ln. 21-23, and col. 13, ln. 28-34. Radwanski illustrates “generally laterally coextensive” slots 11 and 17 in FIG. 1. U.S. Pat. No. 4,411,787 by Riley uses the term “generally laterally coextensive” in claim 1 to relate components of a reverse osmosis apparatus. Riley further discusses that particular term at col. 2, ln. 39-41. U.S. Pat. No. 3,958,578 by Tennant uses the term “generally laterally coextensive” in claim 8 in describing its anti-pronating device.

As for the phrases “generally insulative” and “generally conductive,” U.S. Pat. No. 5,087,589 by Chapman uses both terms in its claims. In claim 20, Chapman expresses a method wherein a “generally insulative” layer receives an implant in a region, that implant is activated, and that region becomes “generally conductive” as a result. Chapman's claim 21 refers again to an analogous “generally insulative” layer, but in this claim the “generally conductive” term refers to underlying wiring. Chapman's specification describes an insulative layer as having a resistivity of “approximately” 10^{14} ohm-cm. (Chapman at col. 9, ln. 5-7.) Chapman's specification provides varying examples of conductive materials as having a resistance of less than 20 ohms (*id.* at col. 5,

ln. 6); one ohm (*id.* at col. 9, ln. 3); “on the order of” 25 ohms or less (*id.* at col. 10, ln. 50-51); less than 25 ohms (*id.* at ln. 67); less than 4 ohms (*id.* at ln. 68); 20 ohms (*id.* at col. 11, ln. 19); and “on the order of” 10-20 ohms (*id.* at ln. 62; *see also id.* at ln. 67). Chapman’s specification also provides varying examples of conductive materials by describing them in terms of their resistivity. In describing the conductivity of prior art devices, Chapman describes a conductive path having a resistivity of “about” 10^{-4} ohm-cm or less. (*Id.* at col. 3, ln. 46-47.) The description of Chapman’s invention subsequently suggests that the notion of conductivity is broader by an order of magnitude, allowing for a resistivity of “about” 10^{-3} ohm-cm or less. (*Id.* at col. 6, ln. 46.) Chapman’s parent, U.S. Pat. No. 4,843,034 by Herndon uses the terms “generally insulative” and “generally conductive” in its claims 20 and 21 in much the same way as did Chapman’s claims 20-21. In a further parallel to Chapman, Herndon also uses many of Chapman’s varying ranges, magnitudes, units of measurement, and terms that grant leeway such as “about” and “approximately,” in addressing insulative and conductive materials. Herndon uses an additional “leeway” term in describing a conductive path having a resistance “on the order of” 1.5 ohms. (Herndon at col. 9, ln. 7.) Significantly, Herndon also specifies a resistance of less than 1 ohm for a via having specific dimensions (*id.* at ln. 63), thereby suggesting that a component’s desired resistance/conductivity would depend upon the particular dimensions of that component.

Thus, one of ordinary skill in the art, viewing the appealed claims, would be aware of the references cited above and as a result, be aware of the terms “generally insulative material,” “generally conductive element,” “generally laterally coextensive,” and what those terms stand for.

b) Analogy between case precedent and the facts on appeal support definiteness

Further, the fact that publications using these terms in such a manner exist as issued patents suggests that some degree of variation is allowed in claims while still meeting the definiteness standards of §112 ¶2. That suggestion is verified by case precedent that highlights yet another factor in determining whether the ordinary artisan would be reasonably apprised of the invention’s scope. Specifically, case precedent teaches that the degree of precision necessary for adequate claims under §112 ¶2 is a function of the nature of the subject matter. (*Miles*, 27

U.S.P.Q.2d at 1126; *see also Orthokinetics*, 1 U.S.P.Q.2d at 1088 (Fed. Cir. 1986); *Chemical Separation*, 63 U.S.P.Q.2d at 1123-1124.) The facts of the latter two examples of case precedent cited above are particularly analogous to the current facts. Those cases indicate that claim terms that permit “leeway” may nevertheless meet the definiteness requirement of §112 ¶2 if one of ordinary skill in the art (1) would understand that the claim addresses within its scope various embodiments; and (2) could determine with relative ease how such terms apply to certain embodiments. For example, the claims in *Orthokinetics* were device claims directed to a wheelchair, a portion of which being “so dimensioned” as to be insertable through a space in an automobile. (*Orthokinetics*, 1 U.S.P.Q.2d at 1088.) In addressing whether the phrase “so dimensioned” satisfied §112 ¶2, the Federal Circuit noted that the claims included within their scope various types of automobiles. (*Id.*) The Federal Circuit also noted that automobiles are of various sizes. (*Id.*) However, the Federal Circuit held that patent law does not require that all possible lengths corresponding to the spaces in hundreds of automobiles be listed either in the claims or even in the specification. (*Id.*) Rather, the court reasoned that one of ordinary skill in the art could easily obtain the necessary dimensions in a particular embodiment. (*Id.*) Thus, the Federal Circuit concluded that §112 ¶2 required nothing more and that the phrase “so dimensioned” is as accurate as the subject matter permits. (*Id.*)

As another example, the relevant limitation in *Chemical Separation* concerned adjusting waste water’s pH range from “about” 5 to “about” 12 as part of a method for removing contaminants from that waste water. (*Chemical Separation*, 63 U.S.P.Q.2d at 1122.) In determining whether the term “about” was sufficiently definite, the court acknowledged that the term does permit some leeway in the amount of a required constituent in the claim and that it would not be feasible to attach a precise limit to the term. (*Id.* at 1123-24.) Nevertheless, the court indicated that the usage of the term could usually be understood in light of the technology embodied in the invention. (*Id.* at 1124) In the case of *Chemical Separation*, the technology concerned contaminated waste water, and the court noted that the invention applied to a “wide range” of waste water streams. (*Id.*) The court further noted that one of ordinary skill in the art would be able to determine the pH necessary in a particular case. (*Id.*) As a result, the court concluded that some imprecision in the actual pH range is necessary yet meets the definiteness requirements of §112 ¶2. (*Id.*)

Similarly, it is true that claim 60's terms "generally insulative material," "generally conductive element," and "generally laterally coextensive" permit some leeway in the amount of a required constituent in the claim. More particularly, the terms "generally insulative material" and "generally conductive element" include within their scope materials with varying degrees of insulation/conductivity, while the term "generally laterally coextensive" includes within its scope various degrees of lateral coextension. Hence, it would not be feasible to attach a precise limit to the terms. However, it is also true that one of ordinary skill in the art would understand that claim 60 addresses a wide range of various substrate processing methods that, in turn, address a wide range of various conductive materials, insulative materials, and lateral coextensivities. This is understood by the Specifications's multiple exemplary yet non-limiting embodiments addressed above, the ordinary artisan's prior knowledge of those terms and how they are used, and the general proposition that a claim may be broader in scope than indicated by such embodiments (*In re Rasmussen*, 650 F.2d 1212, 1215, 211 U.S.P.Q. 323, 326 (C.C.P.A. 1981) (emphasizing "that a claim may be broader than the specific embodiment disclosed in a specification is in itself of no moment"))).

It is also true that one of ordinary skill in the art would be able to easily determine the necessary conductivity/insulation/lateral coextension in a particular embodiment covered within claim 60's scope, as demonstrated by the very references cited above that use those terms. Payne, for instance, expresses that one of ordinary skill in the art will realize that numerous modifications and changes are possible and that Payne's invention has a variety of applications. (Payne at col. 8, ln. 13-22.) Radwanski acknowledges that one of ordinary skill in the art will appreciate that other embodiments, modifications, and variants of its invention are possible. (Radwanski at col. 18, ln. 55-61.) Tennant emphasizes that such an artisan will be able to make various changes in the details, materials, and arrangements concerning its invention. (Tennant at col. 5, ln. 14-21.)

Thus, based on the analogy between the facts of the appealed application and those of binding and persuasive case precedent, the outcome should be similarly analogous: the phrases at issue are as accurate as the art permits, and §112 ¶2 requires no more than what is already in the Specification and claims. Accordingly, Applicants request that the Board reverse the Examiner and withdraw the §112 ¶2 rejection of claim 60.

B. The Examiner has failed to meet the burden for any of the rejections under 35 U.S.C.

§103

The Examiner rejected different groups of the appealed claims as being obvious based on different combinations of references. Applicants address each combination of references separately below.

1. The Examiner has failed to meet the burden for rejection based on a combination of Doan and Boland.

In the latest Final Office Action, the Examiner rejected claim 52 as being obvious in light of Doan (U.S. Pat. No. 5,372,974) in combination with Boland (U.S. Pat. No. 5,084,407). This attempted combination raises several issues which Applicants address separately below.

a) The Examiner's citation to Doan does not support the Examiner's argument

In attempting to reject claim 52 based on a Doan/Boland combination, the Examiner began by arguing that the structure illustrated in Doan's figure 6 and described at Doan's col. 4, lines 17-20, 28-44 disclosed properties such as (1) allowing electrically chargeable particles to occur in a dielectric layer; (2) allowing some diffusion of the electrically chargeable particles; and (3) preventing at least some of the electrically chargeable particles from reaching a substrate. (Office Action dated 8/21/02 at p. 3-4 ¶¶5.) Applicants contend that a careful reading by the Board of Doan's cited figure and text will reveal no such disclosure. Doan's figure 6 merely illustrates a first layer 30, with a film 40 thereover, and a second layer 50 over film 40. Doan's col. 4, lines 17-20 merely addresses film 40 "structurally" by disclosing exemplary materials. Doan's col. 4, lines 28-44 merely addresses layer 50 in terms of its location with respect to film 40, exemplary materials, coefficient of thermal expansion (CTE), and exemplary formation methods. The properties articulated by the Examiner are simply not expressed in the citations. Thus, at best, the Examiner's rejection of claim 52 is based on a misinterpretation of Doan, thereby warranting the Board's reversal of the Examiner and allowance of claim 52.

However, Applicants find it significant that the Examiner attempted to make a similar argument in the previous Final Office Action, dated 2/1/02, wherein the Examiner cited Doan as disclosing the same properties. (*Compare* Final Office Action, dated 8/21/02 at p. 3-4 ¶¶5 *with* Final Office Action dated 2/1/02 p. 3 at ¶¶5.) The previous Final Office Action, however, admits to actually relying on teachings deemed by the Examiner to be inherent, rather than expressed, in Doan. (Final Office Action dated 2/1/02 p. 3 at ¶¶5.) The latest Final Office Action contains the same conclusions based on the same reference yet curiously omits any form of the term “inherent” and instead purports to rely on Doan’s structure as disclosing the cited properties. (Final Office Action, dated 8/21/02 at p. 3-4 ¶¶5.)

The rewording may be due to Applicants’ previous reminder of the impropriety of the Examiner baselessly concluding what teachings are inherent in a reference. (See Appeal Brief submitted 7/9/02 at p. 9 (citing *In re Zurko*, 258 F.3d 1379, 59 U.S.P.Q.2d 1693, 1697 (Fed. Cir. 2001).) Regardless of why the Examiner has reworded the argument, Applicants point out that the Examiner’s “new” argument still (1) relies on the same reference cited in the “old” argument; (2) purports that the reference discloses the same properties asserted in the “old” argument; and (3) supports the same conclusion as the “old” argument’s. Applicants also reiterate that the particular citations in this “new” argument simply do not disclose what the Examiner says they do. Such indications demonstrate that the “new” argument is still one based on what the Examiner deems to be inherent teachings of Doan. Applicants request that the Board not be misled by the lack of the term “inherent” in the latest argument and treat the argument accordingly. Applicants also note that courts tend to frown on attempts by the Patent and Trademark Office (PTO) to disguise one argument as another. (*In re Heyl*, 379 F.2d 1018, 154 U.S.P.Q. 178, 181 (C.C.P.A. 1967) (identifying the PTO’s purported double patenting argument as an “ill-disguised” §112 argument and declining to consider it).) Applicants respectfully request that the Board avoid any invitation for court reversal by reversing the Examiner and withdrawing the rejection.

Moreover, the Examiner’s reliance on Doan’s structure to disclose the Examiner’s articulated properties suggests a conflict with other binding case precedent. Such precedent holds that a prior art reference cannot be assumed to inherently contain a particular property just because it discloses a particular structure. (See *Crown Operations Intl. v. Solutia, Inc.*, 289 F.3d 1367, 62 U.S.P.Q.2d 1917 (Fed. Cir. 2002).) The relevant claim in *Crown* addressed a glass

assembly including a “solar control film.” (*Id.* at 1918-19.) The specific limitation at issue concerned limiting the solar control film’s contribution of visible light reflection to no more than 2% of the total reflection from the whole glass assembly. (*Id.*) The accused infringer argued that a prior art reference disclosed the same structure, materials, composition, and thickness as the claim. (*Id.* at 1919, 1922.) The accused infringer admitted that the prior art reference failed to express the 2% reflection property. (*Id.*) Nevertheless, the accused infringer concluded that such a property is inherent given the similarity in structure, materials, and thickness between the prior art reference’s disclosure and the claim. (*Id.*) In finding against the accused infringer, the Court reasoned that if the unexpressed teaching of the property were inherent in a reference, one of ordinary skill in the art would recognize the teaching’s presence in that reference. (*Id.* at 1922-23.) The Court indicated that it was the accused infringer’s burden to demonstrate that one of ordinary skill in the art would make such a recognition. (*See id.* at 1923.) The Court further indicated that merely pointing out the similarity in structure between the claim and prior art does not meet that burden and, in fact, is not in accordance with the Court’s cases on inherency. (*See id.* at 1922.)

Applicants contend that the current facts are analogous. Claim 52 requires allowing electrically chargeable particles to occur in a dielectric layer; allowing some diffusion of the electrically chargeable particles; and preventing at least some of the electrically chargeable particles from reaching a substrate. As *partial* support for these limitations, Applicants rely on FIG. 3 of the Application and related text in the Specification, which refer to a barrier layer 30 (which may be a nitride) under a dielectric layer 20 (which may be tetraethylorthosilicate (TEOS)-based). The portions of Doan relied upon by the Examiner “structurally” disclose a film 40 that can comprise silicon nitride (Doan at col. 4, ln. 17-20) under a layer 50 that comprises TEOS (*id.* at ln. 28-44). (*See also* Doan at fig. 6.) However, nothing in Doan’s cited portions address the properties of the disclosed structure (except for the reference to the CTE); and nothing at all in Doan’s cited portions address the properties expressed in Applicants’ claim 52. Further, the Examiner’s reliance in the previous Final Office Action on teachings deemed to be inherent is an effective admission that Doan fails to express such properties. (Final Office Action dated 2/1/02 p. 3 at ¶#5). Moreover, the Examiner’s Doan citation in the latest Final Office Action does nothing to refute that admission (see above). Thus, according to *Crown*, if such properties are inherent in Doan’s teachings, then one of ordinary skill in the art should recognize that. (*See Crown*, 62 U.S.P.Q.2d at 1922-23.) However, it is up to the Examiner, who has the

initial burden (just as *Crown*'s accused infringer did) to demonstrate such recognition from one of ordinary skill in the art. (See *id.* at 1923.) Further, the Examiner's citation to Doan's fig. 6 structure and related text is insufficient to meet that burden. (See *id.* at 1922.)

Thus, the rejection of claim 52 is based on either the Examiner's misinterpretation of a cited reference or on a disguised inherency argument that lacks support. Either alternative warrants the Board's reversal of the Examiner and allowance of claim 52.

b) When viewed as a whole, Doan and Boland conflict to a degree that would discourage one of ordinary skill in the art from combining.

Assuming *arguendo* that the Board finds the Examiner's interpretation of Doan to be valid, there are still other problems with the rejection that warrant the Board's reversal. The problems arise from the Examiner's attempt to combine the teachings of Doan and Boland. The Examiner proposed combining the teachings of Doan and Boland such that Doan's method would be practiced over Boland's planarized surface, which consists of dielectric islands (elements 12) and active areas (elements 22). (Office Action dated 8/21/02 at p. 4.) While the Examiner attempted to provide a motive for combining, Applicants submit that, when Doan and Boland are viewed as a whole, they contain conflicts to the extent that would discourage one of ordinary skill in the art from combining.

Binding case precedent in fact requires that the references be considered as a whole:

[w]hen prior art references require selective combination . . . to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gleaned from the invention itself. There must be "something in the prior art *as a whole* to suggest the desirability, and thus the obviousness, of making the combination". . . . Not only must the claimed invention as a whole be evaluated, but so also must the references *as a whole*

. . . .

(*Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 227 U.S.P.Q. 543, 551 (Fed. Cir. 1985) (citations omitted) (emphasis added). See also *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 U.S.P.Q. 303, 308, 311 (Fed. Cir. 1983) (requiring that section 103 references be assessed in their entireties), *cert. denied*, 469 U.S. 851 (1984).) Even case precedent cited by the Examiner earlier in prosecution is consistent with this requirement. *In re*

McLaughlin (443 F.2d 1392, 170 U.S.P.Q. 209 (C.C.P.A. 1971)) emphasizes that, in considering whether to combine references for an obviousness rejection, the Examiner must consider what the references “*taken as a whole* would suggest to one of ordinary skill in the art.” (*McLaughlin*, 170 U.S.P.Q. at 212 (emphasis added).)

Further, when the prior art contains conflicting references, the ability of each reference to suggest solutions to one of ordinary skill in the art must be considered. (See *In re Young*, 927 F.2d 588, 18 U.S.P.Q.2d 1089, 1091 (Fed. Cir. 1991).) Applicants assert that considering the references as a whole necessitates more than merely focusing on their points that may arguably support an obviousness rejection; rather, it further requires considering the conflicts between the references, as required by *Young*.

Applying such standards to the Examiner’s references brings to light the fact that each reference achieves planarization in a distinct way that renders the method in the alternative reference unnecessary and even undesirable. Boland, for example, is content to planarize using chemical-mechanical planarization (CMP). (Boland at Abstract; col. 3, ln. 50- col. 4, ln. 14; claims 1-8 (limiting the planarizing step to one using chemical-mechanical means); claim 9 (limiting the removing step to one using chemical-mechanical means).) It follows that one of ordinary skill in the art seeking to planarize layers subsequently provided over Boland’s dielectric island/active area surface would turn once again to the CMP method touted by Boland. Hence, one of ordinary skill in the art, keeping Boland’s teachings in mind, would view including Doan’s barrier layer as adding unnecessary time, expense, and process complexity to forming a Boland-type device. Further, such an artisan would view Doan’s thermal reflow methods as consuming an unnecessary portion of the thermal budget allotted to fabricating a device. (See Doan at col. 1, ln. 25 and col. 2, ln. 20 (highlighting the issue of thermal budget concerns).)

Conversely, Doan’s focus is planarization by way of thermal reflow. (Doan at col. 2, ln. 13; col. 3, ln. 13; col. 4, ln. 47-49; claims 1-18, step (d).) Further, Doan seeks to isolate layers from stress that may deform the surface of those layers during planarization. (Doan at col. 3, ln. 60-col. 4, ln. 27.) However, the mechanical aspects of Boland’s CMP may very well expose at least one of Doan’s layers to stresses having a result similar to one that Doan seeks to avoid. Hence, one of ordinary skill in the art, keeping Doan’s teachings in mind, would view including Boland’s process in forming a Doan-type device as defeating the very goal of Doan.

Thus, when considered as a whole, Doan and Boland conflict on a level so fundamental that one of ordinary skill in the art would be discouraged from attempting this or any other combination of their teachings. Such a conclusion provides further support for the Board's reversal of the Examiner and allowance of claim 52.

As for the Examiner's attempt to provide a motive to combine, the Examiner based the purported motive on Boland's own expressed need for smaller, denser devices with a larger number of vertically stacked layers. (Office Action dated 8/21/02 at p. 4 (citing Boland Abstract and col. 1, ln. 9-29).) However, Applicants contend that one of ordinary skill in the art would be led to believe that (1) Boland itself satisfies that need; and (2) given the conflicts articulated above, attempts at combining Boland with Doan risks frustrating that need and perhaps actively countering it. As a result, Applicants contend that the Examiner's proposed motive to combine is untenable and, for the reasons discussed above, one of ordinary skill in the art would be actively discouraged from combining Doan and Boland. Accordingly, the Board's reversal of the Examiner and allowance of claim 52 is further supported.

c) The Examiner's rejection demonstrates an improper use of hindsight gained from the current application's teachings

Moreover, the Examiner's ability to ignore the fundamental conflicts between the references and instead focus solely on portions of Doan and Boland that purportedly support rejection indicate that the Examiner is relying on guidance from the current application. In using the current application in such a manner, the Examiner has violated another tenet of *McLaughlin*, which requires that the "judgment on obviousness . . . not include knowledge gleaned only from applicant's disclosure." (*McLaughlin*, 170 U.S.P.Q. at 212.) As a result, the Board's reversal of the Examiner and allowance of the claims is still further supported.

2. The Examiner has failed to meet the burden for rejection based on a combination of Doan and Cunningham

The Examiner rejected claims 53-57 as obvious in light of Doan in combination with Cunningham (U.S. Patent 5,468,689). However, the Examiner's attempt to apply Doan suffers

problems similar to those suffered in the previous combination. In addition, when the references are considered as a whole, their conflicts discourage combination. Such consideration also refutes the Examiner's stated motive to combine.

a) The Examiner's attempt to apply Doan results in a misinterpretation or an ill-disguised inherency argument

The previous Final Office Action raised a very similar Doan/Cunningham rejection, only there the Examiner admitted to relying on teachings deemed to be inherent in Doan. (*Compare* Final Office Action, dated 8/21/02 at p. 4-6, §6 with Final Office Action dated 2/1/02 at p. 4-5, §6.) As before, the latest rejection cites the same references for the same reasons and makes the same conclusions, but any reference to inherency has been replaced by specific citations to Doan. (*Id.*) Once again, the Board's careful reading of the Examiner's citations will reveal that the text does not express the properties the Examiner says it does.

For instance, the Examiner once again cites Doan's fig. 6 and col. 4, lines 28-44, arguing that it discloses (1) allowing electrically chargeable particles to occur in a dielectric layer; (2) allowing an organic component of the organic precursor to deposit in the dielectric layer; and (3) allowing some diffusion of the electrically chargeable particles. (Office Action dated 8/21/02 at p. 4.) As mentioned above, however, Doan's figure 6 merely illustrates a first layer 30, with a film 40 thereover, and a second layer 50 over film 40. Doan's col. 4, lines 28-44 merely addresses layer 50 in terms of its location with respect to film 40, exemplary materials, CTE, and exemplary formation methods.

The Examiner cited Doan's fig. 6 and all of the text from col. 3, lines 60-68 and col. 4, lines 1-44 as disclosing the property of preventing at least some of the electrically chargeable particles from reaching a substrate. (Office Action dated 8/21/02 at p. 3-4, §5.) However, the actual disclosure of Doan's fig. 6 is addressed immediately above. As for Doan's col. 3, ln. 60 – col. 4, line 16, it merely introduces film 40, mentions that film's location with respect to first layer 30, and discloses exemplary processes for film 40's formation and exemplary parameters for those processes, including source gases. Applicants indicated above that Doan's col. 4, ln. 17-20 merely addresses film 40 "structurally" by disclosing exemplary materials. Doan's col. 4, ln. 20-27 merely further address film 40's chemical makeup and its process gases as well as its

rigidity, structural integrity, and CTE. Regarding Doan's col. 4, ln. 28-44, Applicants addressed that excerpt immediately above.

Applicants submit that nowhere in the portions cited by the Examiner will the Board be able to find the properties articulated by the Examiner. Thus, once again the Examiner's argument either suffers from a misinterpretation of Doan or is an argument that is an ill-disguised and unsupported inherency argument. Either alternative warrants the Board's reversal of the Examiner and allowance of the claims.

b) The conflicts between Doan and Cunningham discourage combination

Further, the substance of the Examiner's argument appears in an even earlier Office Action. (*Compare* Office Action dated 8/21/02 at p. 4-6 *and* Office Action dated 2/1/02 at p. 4-5 *with* Office Action dated 9/4/01 at p. 3-5.) Accordingly, Applicants have already presented counter arguments in the Amendment and Response to the Office Action dated 9/4/01.

Applicants submit that those counter arguments still apply and refute the Examiner's current rejection. Once again, Applicants refer the Board to the copy of the Amendment and Response that is included in an appendix. To briefly reiterate those counter arguments, Applicants cited binding case precedent – *Young* (addressed in part B(1)(b) above) – which requires the Examiner to consider the ability of one of ordinary skill in the art to combine references given conflicts between them. (Amendment and Response at p. 4-5.)

Applicants then pointed out that Doan and Cunningham conflict to such an extent that one of ordinary skill in the art would be actively discouraged from combination. (*Id.* at 5.) Specifically, it is noteworthy that Cunningham touts concern over material cracking during a thermal process. (Cunningham at col. 1, ln. 45-53.) As a result, Cunningham teaches providing a nitride barrier 14 over its "top" layer 13. (*Id.*; *see also* col. 3, ln. 21-38; FIG. 1.) Significantly, however, Cunningham does not provide its nitride barrier between layers 12 and 13 that comprise its stack. (*Id.*) Thus, one of ordinary skill in the art is lead to believe that there is no need for such a barrier in that location and hence, no cracking issues there. On the other hand, Doan, which also expresses concern over material cracking during a thermal process, indicates that cracking between layers of the stack is a major problem. Specifically, Doan teaches providing a nitride barrier between each and every layer of its stack. (Doan at col. 4, ln 28- col.

5, ln. 9; FIGS. 6-7.) Thus, in light of Cunningham, Doan appears to one of ordinary skill in the art to require unnecessary redundancy in terms of barrier layers, thereby adding unnecessary time, money, and effort to the fabrication process. Conversely, in light of Doan, Cunningham appears to the artisan to leave its device susceptible to the very cracking problem Cunningham seeks to avoid. Given such fundamental conflicts, Applicants assert that the references lack the ability to suggest solutions to one of ordinary skill in the art and in fact discourage their combination.

The Examiner has previously responded to this counter argument, admitting that “[t]he only teaching that the examiner has gleaned from Cunningham is a method of forming a nitride layer using a non-organic precursor.” (Office Action dated 2/1/02 at p. 9.) The Examiner’s admission indicates a failure to abide by binding case precedent (addressed in detail above in part B(1)(b)) that requires the Examiner to consider a reference’s teachings *as a whole*. (See *Interconnect*, 227 U.S.P.Q. at 551; *Gore*, 220 U.S.P.Q. at 308, 311; *McLaughlin*, 170 U.S.P.Q. at 212.)

Applicants once again assert that considering the references as a whole necessitates more than merely focusing on their points that may arguably support an obviousness rejection; rather, it further requires considering the conflicts between the references, as required by *Young*. The Examiner failed to address such conflicts in the previous Office Actions, even after being reminded by Applicants. (Amendment and Response at p. 5; Appeal Brief submitted 7/9/02 at p. 10.) As a result, the Examiner’s admitted conduct is legally improper under binding case precedent, thereby further supporting the Board’s reversal of the Examiner and allowance of the claims.

Moreover, the Examiner’s ability to focus solely on portions of Cunningham that purportedly support rejection indicate that the Examiner is relying on guidance from the current application. In using the current application in such a manner, the Examiner has violated another tenet of *McLaughlin*, which requires that the “judgment on obviousness . . . not include knowledge gleaned only from applicant’s disclosure.” (*McLaughlin*, 170 U.S.P.Q. at 212.) Thus, the Examiner’s admitted conduct indicates legal impropriety under yet another standard set forth by the very case previously cited by the Examiner. As a result, the Board’s reversal of the Examiner and allowance of claims 53-57 is further supported.

c) The Examiner's stated motive for combination is untenable

As for the Examiner's attempt to provide a motive to combine, the Examiner based the purported motive on Cunningham's own expressed benefit of a barrier layer that can withstand oxide desorption at temperatures in excess of 900 degrees Centigrade. (Office Action dated 8/21/02 at p. 5 (articulated twice) (citing Cunningham at col. 1, ln. 44-45).) However, when that Cunningham excerpt is read in context, its use as a motive for applying Cunningham's teachings to Doan become questionable. Specifically, Cunningham touts a barrier layer that can withstand oxide desorption at temperatures in excess of 900 degrees Centigrade as being "necessary for the successful growth of gallium arsenide." (Cunningham at col. 1, ln. 43-46.) Nothing in Doan, however, suggests a need for growing gallium arsenide. Rather, Doan focuses its needs on reflowing multiple layers made from different materials. Thus, the motive articulated by the Examiner and expressed by Cunningham would not appear to one of ordinary skill in the art to be relevant to Doan's issues. Further, given the conflicts articulated above, one of ordinary skill in the art would be actively discouraged from combining Cunningham with Doan. As a result, Applicants contend that the Examiner's proposed motive to combine is untenable and, in fact, there is active discouragement from combining. Accordingly, the Board's reversal of the Examiner and allowance of claims 53-57 is further supported.

3. The Examiner has failed to meet the burden for rejection based on a combination of Doan, Cunningham, and Ying.

The Examiner rejected claims 58 and 59 as obvious in light of Doan and Cunningham in combination with Ying (U.S. Patent 5,384,288). Applicants note that the Examiner has raised analogous rejections in the two Office Actions prior to the latest one. (*Compare* Office Action dated 8/21/02 at p. 6-7 *with* Office Action dated 2/1/02 at p. 5-6 *and* Office Action dated 9/4/01 at p. 5-6.) Accordingly, Applicants have already presented counter arguments in the Amendment and Response to the Office Action dated 9/4/01. Applicants submit that those counter arguments still apply and refute the Examiner's rejection. Those counter arguments, however, refer to still other counter arguments presented in an even earlier Response. Thus, for the sake of clarity, Applicants consolidate the substance of the arguments (and supplement them) below.

a) The Examiner's attempt to combine two of the three cited references has already been refuted

First, Applicants note that the Examiner argues that Doan and Cunningham apply to claims 58-59 in the same manner as those references applied to claims 55-57. (Office Action dated 8/21/02 at p. 6.) However, as addressed above, the Examiner's application of Doan and Cunningham is faulty to the point that it warrants the Board's reversal of the Examiner and allowance of claims 55-57. Accordingly, Applicants submit that the Examiner's faulty application of Doan and Cunningham is sufficient for the Board's reversal of the Examiner and allowance of claims 58-59 as well.

b) Conflicts between Doan, Cunningham, and Ying discourage combination

Second, the problem with attempting to combine Doan, Cunningham, and Ying is that each reference conflicts with the other two to such an extent that one of ordinary skill in the art, considering the references as a whole, would be discouraged from combining their teachings. The conflicts between Doan and Cunningham have already been discussed in the section above, and Applicants assert that such conflict is sufficient to defeat this obviousness rejection as well.

As further support for withdrawing this rejection, Ying also conflicts with both Doan and Cunningham. Considering Ying and Doan, for example, the references' teachings conflict on a very fundamental level. Specifically, while both teach methods concerning providing a planarized surface, their methods are completely contradictory. Doan proposes interposing between two layers a film with enough rigidity and structural integrity to prevent the stresses from one layer from affecting the other during a reflow process. (Doan at Abstract; col. 4, ln. 17-27; ln. 44-60.) To do otherwise would allow the layers' differences in coefficients of thermal expansion to cause a buckling effect. (*Id.* at col. 1, ln. 28-40.) Ying, to the contrary, teaches creating, exacerbating, and transmitting stress to layers in order to aid in planarization, the thought being that the stress will lower the temperature at which the layers will reflow. (Ying at Abstract; col. 4, ln. 10-14; ln. 23-26; 48-50; 65-68.) Applicants contend that one of ordinary

skill in the art would be discouraged from even attempting to combine the teachings of references that offer completely contradictory strategies for dealing with the same problem.

Ying and Cunningham conflict as well. Significantly, the processes taught in both references require a barrier material such as a nitride. Cunningham requires that its nitride barrier 14 expose a portion of a silicon substrate 11 in order to grow GaAs thereon. (Cunningham at col. 3, ln. 21-38; FIG. 1.) Ying, on the other hand, requires that its nitride barrier 14 expose none of the substrate 10 in order to protect the substrate 10 from subsequent processing. (Ying at col. 3, ln. 18-28; FIGS. 1A-1C, 2A-B, 3, 4A-B.) Thus, one of ordinary skill in the art attempting to combine the references would achieve a Cunningham-type device with a continuous nitride barrier that covers the substrate and hinders the desirable growth of GaAs. Alternatively, the artisan would achieve a Ying-type device having a nitride barrier that exposes the substrate, thereby allowing undesirable deterioration during subsequent processing. Either combination is unworkable and hence provides further discouragement in attempting a Doan/Cunningham/Ying combination.

More fundamentally, it is noteworthy that, although Ying allows for a high temperature in its process for “a few seconds” (Ying at col. 4, ln. 21), Ying generally teaches against high temperature processes – particularly those involving 900° C or more -- because they cause degradation of the underlying semiconductor device. (*Id.* at col. 1, ln. 56-59; col. 4, ln. 30-33.) The Examiner even points this out in an attempt to provide a motive for one of ordinary skill in the art to apply Ying to Doan and Cunningham. (Office Action dated 8/21/02 at p. 6, 7.) Cunningham, in contrast, indicates that “temperatures in excess of 900 degrees Centigrade . . . are necessary” for the successful gallium arsenide growth it touts. (Cunningham at col. 1, ln. 44-46.) Significantly, the Examiner twice relies on this point in Cunningham. (Office Action dated 8/21/02 at p. 5.) Moreover, Cunningham’s disclosed test data indicates that such temperatures are sustained for an hour. (Cunningham col. 4, ln. 14-16; Table 1.) Thus, the express language of Cunningham and Ying, as well as the Examiner’s own admissions, demonstrate that Ying encourages long term high temperature processes, while Cunningham eschews such processes in favor of short term high temperature processes and long term low temperature process. Applicants assert that the opposing nature of the processes in Ying and Cunningham demonstrate the fundamental conflicts between the two references that would still further discourage one of ordinary skill in the art from any combination involving both Cunningham and Ying.

c) The Examiner has previously admitted failure to abide by case precedent

As mentioned above, Applicants have previously presented at least some of these counter arguments. The Examiner's previous response has been to admit that "[t]he only teaching that the examiner has gleaned from Ying is a specific method of heating a carbon-containing dielectric." (Office Action dated 2/1/02 at p. 9.) As with the Examiner's admission in part 2 above, this latest statement expressly demonstrates the Examiner's failure to consider the references as a whole (deemed legally improper by *Interconnect*, *Gore*, and *McLaughlin*) and indicates an improper use of hindsight gleaned from the current application (deemed legally improper by *McLaughlin*).

Thus, the conflicts between Doan, Cunningham, and Ying; the Examiner's lapse in failing to consider those conflicts; and the Examiner's ability to focus on particular portions of Cunningham and Ying despite those conflicts favor the Board's reversal of the Examiner and allowance of claims 58-59.

d) The Examiner's motive to combine is untenable

As for the Examiner's purported motive to add Ying's teachings to Doan and Cunningham, the Examiner argued that such motivation comes from the desire for a low temperature reflow process that avoids damaging underlying circuitry. (Office Action dated 8/21/02 at p. 6,7.) Although Cunningham briefly refers to reflow (Cunningham at col. 3, ln. 27), Cunningham's focus is blocking diffusion of gallium with a material that will withstand the high-temperature gallium growth process. (Cunningham at col. 1, ln. 43-47.) Further, both Cunningham's plain language and the Examiner's own admissions indicate that Cunningham is not concerned with low temperature processes and in fact deems high temperature processes to be "necessary" for its purposes. (Cunningham at col. 1, ln. 43-47; Office Action dated 8/21/02 at p. 5.) As for Doan, it stresses a fundamental desire for a low stress method of planarization while Ying stresses a fundamental desire for a high stress method of planarization. Applicants contend that such fundamental conflicts between Doan and Ying would cause one of ordinary

skill in the art to reject one reference over the other before ever considering whether to apply the details of one to the other. As a result, the untenable nature of the Examiner's stated motive for combination provides still further support for the Board's reversal of the Examiner and allowance of claims 58-59.

4. The Examiner has failed to meet the burden for rejection based on a combination of Doan and Ghezzi

The Examiner rejected claims 60-61 and 63-64 as being obvious in light of Doan in combination with Ghezzi (U.S. Patent 5,132,239). The latest Final Office Action's Doan/Ghezzi rejection is very similar to the Doan/Ghezzi rejections in previous Office Actions. (*Compare* Office Action dated 8/21/02 at p.7-8 *with* Office Action dated 2/1/02 at p. 6-7, Office Action dated 9/4/01 at p. 6-7, *and* Office Action dated 1/26/01 at p. 4-5.) Accordingly, Applicants' previous arguments, which span several responses and the Appeal Brief transmitted 7/9/02, still apply and refute the Examiner's rejection. Nevertheless, for the sake of clarity, Applicants consolidate and supplement the substance of the arguments below. In summary, Applicants contend that the Examiner has misinterpreted Doan as well as Ghezzi, and that one of ordinary skill in the art would be actively discouraged from combining these references.

a) The Examiner has misapplied Doan

Concerning the Examiner's misinterpretation of Doan, it is noteworthy that the Examiner cites Doan's figure 5 as disclosing a material having the property of being an oxide charge barrier. (Office Action dated 8/21/02 at p. 7.) Applicants alert the Board that Doan's figure 5 merely discloses film 40 over first layer 30. While Doan's text indicates that film 40 may be titanium nitride, the Examiner has failed to cite support in the record addressing either of Doan's structures 30 or 40 having the property of an oxide charge barrier. As a result, the Examiner's citation to figure 5 represents a misinterpretation of Doan that runs afoul of *Crown* (62 U.S.P.Q.2d at 1922-23 (holding that a prior art reference cannot be assumed to inherently contain a particular property just because it discloses a particular structure).)

Another of the Examiner's misinterpretations of Doan stems from the Examiner's argument that Doan discloses depositing an insulative material that is less insulative than an underlying barrier. (Office Action dated 8/21/02 at p. 7.) While Doan indicates that its second layer 50 (1) may be selected from one list of materials; and (2) is over a film 40 that may be selected from another list of materials, there is nothing in Doan specifying the relative insulative qualities of the two layers. (Doan at col. 4, ln. 38-43 (listing materials for layer 50); ln. 17-20 (listing materials for film 40).) This is especially true given that layer 50 could be conductive or insulative. (*Id.* at col. 4, ln. 38-43.) Rather, Doan's focus in terms of material selection is that the material maintain its rigidity and structural integrity upon subsequent heating steps. (*Id.* at col. 4, ln. 17-27.) Because Doan's multiple examples of these structures fails to address their relative insulative properties, the Examiner's argument represents a misinterpretation of Doan that is in contradiction with the binding case precedent in *Crown* (62 U.S.P.Q.2d at 1922-23).

Applicants contend that either one or both of the misinterpretations discussed above are sufficient for the Board's reversal of the Examiner and allowance of claims 60-61 and 63-64. Applicants also note that the Examiner has expressed additional Doan interpretations relating to each of dependent claims 61 and 63-64. Applicants contend that those interpretations are in fact misinterpretations that provide the Board with additional bases for reversal of the Examiner. Hence, each of claims 61 and 63-64 do not necessarily fall with any of the other claims similarly rejected.

i. Claim 61

For example, in attempting to reject dependent claim 61, the Examiner cited Doan's column 4, line 43 as disclosing a material that is allowed to comprise oxide charges. (Office Action dated 8/21/02 at p. 8.) That line, however, merely discloses a TEOS-based structure and does not address any property concerning comprising oxide charges. Thus, the Examiner provides yet another instance of a Doan interpretation that is legally improper in light of *Crown* (62 U.S.P.Q.2d at 1922-23).

ii. Claim 63

As for dependent claim 63, the Examiner's misinterpretations of Doan are even more apparent. In the latest Final Office Action, the Examiner cited Doan's figure 6 and column 4, lines 44-45 as disclosing allowing an oxide charge to migrate in response to an annealing step. (Office Action dated 8/21/02 at p. 8.) However, as mentioned above, Doan's figure 6 merely illustrates a first layer 30, with a film 40 thereover, and a second layer 50 over film 40. Doan's column 4, lines 44-45, merely indicate that, once second layer 50 is formed superjacent film 40, the entire device is then heated. Nowhere in the Examiner's citations are the properties of oxide charge presence, let alone migration, addressed. Thus, the Examiner provides still another instance of a Doan interpretation that is legally improper in light of *Crown* (62 U.S.P.Q.2d at 1922-23). Moreover, Applicants note that in the previous Final Office Action, the Examiner cited the same reference for the same propositions but admitted reliance upon teachings the Examiner deemed to be inherent in Doan. (*Compare* Office Action dated 8/21/02 at p. 8 *with* Office Action dated 2/1/02 at p. 7.) Thus, the Examiner's legal impropriety is compounded by the fact that the latest argument (1) is ill-disguised (*see Heyl*, 154 U.S.P.Q. at 181); and (2) is actually a baseless inherency argument (*see Zurko*, 59 U.S.P.Q.2d at 1697).

The Examiner's legal improprieties are further exacerbated by the fact that the Examiner makes a similar additional misinterpretation in attempting to reject claim 63. Specifically, the Examiner argued in the latest Final Office Action that Doan's figure 6 and column 14, lines 17-20, disclose intercepting an oxide charge. (Office Action dated 8/21/02 at p. 8.) However, (1) Applicants have indicated above that the cited text fails to disclose such properties; and (2) the previous Office Action admitted that the rejection relies on teachings the Examiner believes to be inherent in Doan (*see* Office Action dated 2/1/02 at p. 7). Thus, this interpretation provides still another instance wherein the attempted rejection of claim 63 conflicts with the standards set forth in *Crown*, *Heyl*, and *Zurko*.

iii. Claim 64

Concerning dependent claim 64, the Examiner further interpreted Doan as disclosing refraining from depositing a conductive material before depositing an insulative material. (Office

Action dated 8/21/02 at p. 8.) However, Doan discloses so many options for its relevant layers that it allows for depositing a conductive material (such as tungsten, titanium, copper, or aluminum) before depositing an insulative material (such as tantalum oxide, silicon oxide, or TEOS) and hence cannot be interpreted as disclosing refraining from such alternatives. (See Doan at col. 3, ln. 50 – col. 4, ln. 27.)

b) The Examiner has misapplied Ghezzi

As for the Examiner's reliance on Ghezzi, Applicants contend that the Examiner has misinterpreted that reference as well, thereby providing still more support for the Board's reversal of the Examiner for all of claims 60-61 and 63-64. Specifically, the Examiner assumed that Ghezzi discloses a conductive element (Office Action dated 8/21/02 at p. 7 (citing Ghezzi's element 5 in FIG. 3)) that is coextensive with an insulating region (*id.* (citing Ghezzi's element 21 in FIG. 3)). Ghezzi's insulation 21, however, extends only from one field oxide region 11 to another. Ghezzi's conductive element 5, on the other hand, not only extends over that area but also extends over multiple field oxide regions 11 as well as over coupling area 12. Hence, Ghezzi's conductive element 5 cannot be described as being coextensive with Ghezzi's insulation 21.

c) The Examiner's motive to combine is untenable

As for the purported motive to combine Doan with Ghezzi, the Examiner argued that it would be obvious to use Ghezzi's active areas and conductive element with Doan's process to form Ghezzi's floating gate transistor, wherein the motive to do so is based on the interest of efficiency and reliability, as touted by Ghezzi. (Office Action dated 8/21/02 at p. 7-8.) First, Applicants note that the Examiner has proposed this combination before. (See Office Action dated 2/1/02 at p. 7.) In response, Applicants indicated that the precise configuration of the Examiner's proposed Doan/Ghezzi hybrid is unclear, thereby suggesting a failure to meet the *prima facie* burden for rejection. (Appeal Brief transmitted 7/9/02 at p. 13-14.) As a further result, Applicants ability to address the combination was hindered. Unfortunately, the Examiner has been no more forthcoming with the precise configuration of the proposed Doan/Ghezzi

hybrid in the latest Office Action. Thus, the continued lack of support from the Examiner indicates that the *prima facie* burden for rejection has not and cannot be met.

Second, concerning the Examiner's touted motive to combine, Applicants contend that when Ghezzi's emphasis on efficiency and reliability is read in context, Ghezzi actually teaches away from Doan. Ghezzi's discussion on efficiency and reliability addresses the advantages of providing a single layer for a memory component rather than multiple layers. (Ghezzi at col. 1, ln. 40-44 (specifying polysilicon).) An additional benefit articulated by Ghezzi is process simplicity. (*Id.*) Doan's process, however, necessarily involves multiple layers – at least two layers with a rigid film therebetween. (Doan at figs. 6, 7; *see also* Abstract, col. 1, ln 27; and col. 2, ln. 24 (all referring to “multilayer” structures).) Further, Doan's invention allows for multiple insulative layers, while Ghezzi stresses the need for thin insulation. (*Compare* Doan at col. 3, ln. 57-59 (listing insulative materials for layer 30); col. 4, ln. 17-20 (listing insulative materials for film 40); col. 4, ln. 41-43 (listing insulative materials for layer 50) *with* Ghezzi at Title; Abstract; col. 1, ln. 9, 16, 52-53, 60, 64; col. 2, ln. 5, 8, 12, 15, 19, 27, 29, 31, 36, 39, 46, 49-50; col. 3, ln. 1, 42, 48; claim 1 (all emphasizing a “thin oxide”).) Applicants contend that attempts to use Doan's “multilayer” process to satisfy Ghezzi's “thin oxide” requirements would frustrate not only Ghezzi's “process simplicity” goal but also Ghezzi's efficiency and reliability goals as well. Thus, when Ghezzi's motives are read in context, Applicants contend that those goals conflict with Doan's process to a degree that would discourage one of ordinary skill in the art from combining. This renders the Examiner's purported motive untenable.

In addition, Applicants have previously pointed out still another conflict that would discourage one of ordinary skill in the art from attempting a Doan/Ghezzi combination. (*See* Appeal Brief transmitted 7/9/02 at p. 13.) There, Applicants argued that the goal of Doan's invention is planarity; and the almost informal drawings of Ghezzi suggest that planarity is not an issue (*see* Ghezzi at FIGS. 2, 3, 4).

Thus, the Examiner's rejections of claims 60-61 and 63-64 are at best based on misinterpretations of the references and at worst based on ill-disguised and unfounded inherency arguments. Moreover, the Board's careful reading of Doan and Ghezzi will demonstrate that they not only refute the Examiner's proposed motive to combine but also teach away from each other to such an extent that they discourage combination by an ordinary artisan. Any or all of

these reasons provide the Board with a basis for reversing the Examiner and allowing claims 60-61 and 63-64.

5. The Examiner has failed to meet the burden for rejection based on a combination of Doan, Ghezzi, and Van Der Scheer

The Examiner rejected claim 62 as being obvious in light of Doan and Ghezzi in combination with Van Der Scheer (U.S. Patent 4,976,856). Applicants alert the Board that this latest Doan/Ghezzi/Van Der Scheer rejection is essentially the same as that raised in previous Office Actions. (*Compare* Office Action dated 8/21/02 at p. 8-9 *with* Office Action dated 2/1/02 at p. 8; *and* Office Action dated 9/4/01 at p. 7; *see also* Office Action dated 1/26/01 at p. 6 (using similar language for a §103 rejection based on only Doan and Van Der Scheer.) Accordingly, Applicants' still applicable counter arguments span across multiple Responses and the Appeal Brief transmitted 7/9/02. Thus, for the sake of clarity, Applicants consolidate and supplement the substance of the arguments below.

First, Applicants note that the Examiner argues that Doan and Ghezzi apply to claim 62 in the same manner as those references applied to claim 60. (Office Action dated 8/21/02 at p. 8.) However, as addressed above, the Examiner's application of Doan and Ghezzi is faulty to the point that it warrants the Board's reversal of the Examiner and allowance of claim 60. Accordingly, Applicants submit that the Examiner's faulty application of Doan and Ghezzi is sufficient for the Board's reversal of the Examiner and allowance of claim 62 as well.

Second, the problem with attempting to combine Doan, Ghezzi, and Van Der Scheer is that each reference conflicts with the other two to such an extent that one of ordinary skill in the art, considering the references as a whole, would be discouraged from combining their teachings. The conflicts between Doan and Ghezzi have already been discussed in the section above, and Applicants assert that such conflict is sufficient to defeat this obviousness rejection as well.

As further support for withdrawing this rejection, Van Der Scheer also conflicts with both Doan and Ghezzi. Considering Van Der Scheer and Doan, for example, it is noteworthy that Doan's process is directed to providing a planar surface. (Doan at col. 1, ln. 12-13.) Van Der Scheer, on the other hand, is in no way concerned about the planarity of its workpiece. Specifically, Van Der Scheer indicates that its substrate may have "any suitable shape,"

including a tubular shape, and in fact prefers a tubular substrate because it can withstand high pressure differences. (Van Der Scheer at col. 4, ln. 15-32.)

Similar compatibility issues exist between Van Der Scheer and Ghezzi. Ghezzi's focus is providing different dopant concentrations in a semiconductor substrate so that the gate oxide will grow thereon to different thicknesses. (Ghezzi at col. 2, ln. 64-67.) There is no indication as to how Van Der Scheer's process for forming a non-porous selective membrane would affect or be affected by such a process. As a result, one of ordinary skill in the art would be wary of combination.

Moreover, such conflicts call into question the Examiner's newly-proposed motive for combination. Specifically, the Examiner indicates that one of ordinary skill in the art would be motivated to treat Doan or Ghezzi's substrate using Van Der Scheer's plasma treatment in order to prepare a nonporous membrane with a higher ability to allow select transportation of molecular species. (Office Action dated 8/21/02 at p. 8-9 (citing Van Der Scheer at col. 3, lines 8-20).) However, when the language expressed by the Examiner is considered in context with the entire paragraph cited by the Examiner, one of ordinary skill in the art would find Van Der Scheer's process inapplicable to Doan or Ghezzi. Specifically, Van Der Scheer indicates that the ability to allow select transportation of molecular species is relevant to fields wherein it is desirable to separate gases or to separate liquid hydrocarbons from solvents. (Van Der Scheer at col. 3, lines 8-20) The fact that Van Der Scheer is assigned to Shell Oil Company indicates that such techniques are relevant to the oil business. On the other hand, Doan's art is directed to processing semiconductor wafers, and Ghezzi's art concerns manufacturing EEPROM (electrically erasable programmable read-only memory). Thus, in addition to appearing to be non-analogous art with respect to the claims at issue, Van Der Scheer's teachings also have no relevancy concerning the technologies of Doan and Ghezzi. More specifically, there is nothing in Doan or Ghezzi indicating the desirability of separating gases or to separating liquid hydrocarbons from solvents. Accordingly, one of ordinary skill in the art would lack motivation to combine Doan or Ghezzi with Van Der Scheer because its teachings are directed to a disparate technology.

Further, the Examiner's failure to address the conflicts between the references even after being notified by Applicants suggests that the Examiner has failed to consider the references as a whole, ignored those conflicts, and been able to focus on certain aspects of the references based

on knowledge gleaned from the current application; thus, the Examiner's conduct fails to satisfy the standards set forth in *Interconnect*, *Gore*, *McLaughlin*, and *Young*, which warrants the Board's reversal of the Examiner.

Given the untenable rejection of claim 62's independent claim, the articulated motives to avoid including Van Der Scheer in such a rejection, and the lack of a tenable motivation to include Van Der Scheer as part of an obviousness rejection, the Board's reversal of the Examiner and allowance of claim 62 is warranted.

C. Policy reasons favor the Board's allowance of the claims

As indicated above, all of the arguments raised in the latest Office Action are essentially the same as those raised in the previous one; and some of those arguments can be found in even earlier Office Actions spanning the past two years of prosecution. (*Compare* Office Action dated 8/21/02 *with* Office Action dated 2/1/02; Office Action dated 9/4/01; *and* Office Action dated 1/26/01.) As a result, the latest Office Action represents the culmination of several legal improprieties, any one or combination of which support the Board's reversal of the Examiner and allowance of the appealed claims as a matter of policy.

One example wherein the Examiner's actions frustrate the policies established by the PTO relates to the Examiner's reopening prosecution. The PTO has set forth clear standards for the Examiner's conduct in concerning reopening prosecution after Applicants have initiated the appeal process:

Reopening of Prosecution After Appeal

The examiner may . . . reopen prosecution *to enter a new ground of rejection*

(MPEP §1208.02 (bold in original; italics added).) In applying this standard to the facts relevant to this appeal, Applicants contend that the Examiner's conduct demonstrates the Examiner's failure to act in accordance with this standard and the underlying policy. For example, Applicants note that the Examiner's expressed reason for reopening prosecution is "to correct a minor typographical error." (Office Action dated 8/21/02 at p. 2.) Applicants also note that the only other significant differences between the latest Final Office Action and the previous Final

Office Action appear to be (1) the Examiner's attempt at disguising the inherency arguments; and (2) the Examiner's newly articulated motives to combine the cited references. (*Compare* Office Action dated 8/21/02 *with* Office Action dated 2/1/02.) As for the inherency arguments, Applicants have pointed out several times above not only the impropriety of the attempt at disguising the arguments (*see Heyl*, 154 U.S.P.Q at 181) but also the problems with the inherency arguments themselves (*see Zurko*, 59 U.S.P.Q.2d at 1697; *Crown* (62 U.S.P.Q.2d at 1922-23)). Concerning the motives to combine, Applicants contend that such motives should have been articulated earlier in prosecution given the length of time and number of office actions in which the Examiner has asserted these references in general and these combinations in particular. Applicants submit that the Examiner's admitted and actual reasons for reopening prosecution should not be considered a new ground of rejection. This is especially true when the Examiner's cited combinations, arguments, and conclusions remain almost identical to those presented in the previous Office Actions.

Returning to MPEP §1208.02, it sets forth additional standards concerning the character of the Office Action mailed after reopening prosecution.

The Office Action containing a new ground of rejection may be made final if the new ground of rejection was (A) necessitated by amendment, or (B) based on information presented in an information disclosure statement

(*Id.*) Applicants contend that neither of the conditions that warranted a final Office Action were present when the Examiner mailed the Office Action dated 8/21/02. While Applicants are not arguing against the finality of that Office Action, Applicants do submit that the finality of that Office Action further demonstrates the Examiner's contradiction of the PTO's own standards and their underlying policies.

The substance of the Office Action dated 8/21/02 as well as earlier ones raise an issue with yet another standard set forth by the PTO, one requiring the Examiner to

Answer All Material Traversed

. . . Where the applicant traverses any rejection, the examiner should, if he or she repeats the rejection, take note of the applicant's argument and answer the substance of it.

(MPEP §707.07(f) (emphasis in original).) The substantial similarity between the Examiner's rejections in at least the last two Office Actions demonstrates that the Examiner has repeated a series of rejections. Between the times of mailing those two Office Actions, Applicants submitted an Appeal Brief including fifteen pages of substantive arguments traversing the rejections. The only answer Applicants can discern consists of two sentences in the latest Office Action indicating that Applicants arguments are not persuasive and that Applicants have not fully addressed the rejection of claim 52. (Office Action dated 8/21/02 at p. 9.) Applicants contend that such statements utterly fail to answer the substance found in fifteen pages of the previous Appeal Brief and once again demonstrate the Examiner's failure to satisfy the PTO's own standards and their underlying policies.

More specifically, Applicants note that all but one of the asserted combinations appear at least as far back as the Office Action dated 9/4/01 (the Doan/Boland combination was not asserted until the Office Action dated 2/1/02, but the Doan/Ghezzi combination was first asserted back in the Office Action dated 1/26/01). Applicants subsequently argued against the combinations, indicating that their internal conflicts discourages an ordinary artisan from such combinations. (Amendment and Response to the Office Action dated 9/4/01.) The Examiner's reply was to admit reliance on only specific portions of the references. (Office Action dated 2/1/02 at p. 8-9.) As part of the fifteen pages of substantive arguments in the Appeal Brief transmitted 7/9/02, Applicants emphasized the legal impropriety of the Examiner's failure to consider the references as a whole. The latest Office Action contained no substantive answer to such arguments, thereby frustrating the policies underlying MPEP §707.07(f).

Still other examples abound concerning the Examiner's failure to respond to Applicants' arguments. As mentioned above, Applicants have previously cited dictionary definitions that one of ordinary skill in the art would be aware of, thereby supporting the definiteness of claim 60. (Amendment and Response to the Office Action dated 9/4/01 at p. 3-4.) Applicants could find no answer from the Examiner directed to that argument in the subsequent Office Action, dated 2/1/02. As a result, Applicants reiterated this point in the Appeal Brief transmitted 7/9/02 (see p. 4-5). Applicants still can find no answer from the Examiner directed to that argument in the latest Office Action, dated 8/21/02.

The lack of Examiner answers to arguments against the Doan/Ghezzi combination provide an even more egregious example of the Examiner's failure to satisfy PTO standards. Significantly, the Examiner cited the Doan/Ghezzi combination in the very first Office Action – dated 1/26/01. Accordingly, Applicants responded, pointing out that the Doan/Ghezzi combination fails to disclose at least some of the claim limitations. (Response to the Office Action dated 1/26/01 at p. 4-5.) Applicants also pointed out that the Examiner's motive was conclusory and that in fact the teachings in each reference did not favor combination. (*Id.*) This Response was also the first time that Applicants indicated lack of clarity concerning the modified device envisioned by the Examiner as a result of combining Doan and Ghezzi. (*Id.*) Rather than respond to the points raised by Applicants, the Examiner essentially repeated the rejection in the next Office Action – dated 9/4/01. The Examiner's reply to Applicants' Response consisted of a general admission to relying on hindsight in making the obviousness rejections, with a citation to case law for support. (Office Action dated 9/4/01 at p. 8.) In turn, Applicants subsequently pointed out (1) the similarity of the Doan/Ghezzi rejections in the two prior Office Actions; (2) the intervening counter arguments offered by Applicants; and (3) that the case precedent cited by the Examiner actually favors Applicants. (Response to the Office Action dated 9/4/01 at p. 6-7.) Despite such efforts, the Examiner essentially repeated the Doan/Ghezzi rejection language, again neglecting to respond directly to Applicants' arguments. (Office Action dated 2/1/02 at p. 6-9.) Accordingly, Applicants consolidated and supplemented the counter arguments in the Appeal Brief submitted 7/9/02.

Nevertheless, the Examiner's subsequent and latest Doan/Ghezzi rejection remains basically unchanged, as does the Examiner's resolve to avoid answering Applicants' counter arguments. (*See* Office Action dated 8/21/02 at p. 7-8.) Accordingly, in this Second Appeal Brief, Applicants incorporate, reiterate, and even further supplement the relevant arguments. (*See* section VIII(B)(4) above.) Applicants submit that the Board's review of the prosecution history will reveal that Applicants' arguments countering the other rejections have suffered similarly. Such lapses by the Examiner provide the Board with a legion of examples wherein the Examiner failed to answer the substance of Applicants' arguments, thereby frustrating the policy underlying MPEP §707.07(f).

Applicants further contend that any one or combination of the Examiner's breaches of the required standards of prosecution further supports the Board reversing the Examiner, withdrawing the rejections, and allowing the claims.

D. Conclusion

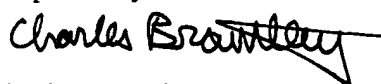
Applicants' arguments presented above demonstrate that one of ordinary skill in the art is reasonably apprised of the scope of the invention in claim 60 given the exemplary yet non-limiting embodiments in the Specification and acknowledged by the Examiner. Such apprising is further demonstrated by pertinent art (including dictionary definitions and existing patents) and analogous case precedent, all of which demonstrate the degree of definiteness to which one of ordinary skill in the art would be accustomed.

Concerning the obviousness rejections, all of them suffer from either a misinterpretation of at least one reference or an ill-disguised and unsupported inherency argument based on a reference. Further, when the references in any of the combinations are considered as a whole, the resulting conflicts indicate that an ordinary artisan would be discouraged from such combinations. Such conflicts refute the Examiner's attempts to provide motives for combination, especially in light of the Examiner's previous admission that the references were not considered as a whole. Applicants have also pointed out that the Examiner's failures suggest that the Examiner used hindsight gained from the current application in making the obviousness rejections, which is counter to binding case precedent as well.

Further, the Examiner's inappropriate conduct concerning (1) reopening prosecution (2) in the form of a final office action that (3) still does not answer the substance of Applicants' arguments supports the Board's reversal of the Examiner and allowance of claims as a matter of policy.

Accordingly, Applicants request that the Board so reverse the Examiner, withdraw the rejections, and allow claims 52-64.

Respectfully submitted,



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Appendix 1: Copy of Involved Claims

52. A method of processing a semiconductor device, comprising:

depositing a dielectric layer over a semiconductor substrate, said substrate comprising a plurality of electrically conductive regions and an electrically insulative region therebetween;

allowing electrically chargeable particles to occur in said dielectric layer;

allowing some diffusion of said electrically chargeable particles; and

preventing at least some of said electrically chargeable particles from reaching said substrate.

53. A method of processing a semiconductor device, comprising:

depositing a dielectric layer over a semiconductor substrate, wherein said step of depositing a dielectric layer comprises depositing a dielectric layer using a organic precursor;

allowing electrically chargeable particles to occur in said dielectric layer, wherein said step of allowing electrically chargeable particles to occur in said dielectric layer comprises allowing an organic component of said organic precursor to deposit in said dielectric layer;

allowing some diffusion of said electrically chargeable particles; and

preventing at least some of said electrically chargeable particles from reaching said substrate, wherein said preventing step comprises layering a barrier over said substrate using a non-organic precursor prior to said step of depositing a dielectric

layer.

54. The method in claim 53, wherein said layering step comprises layering a barrier using silane.

55. A method of at least partially forming a circuit device, comprising:

providing a semiconductor substrate;

layering a carbon-free barrier on said substrate; and

layering a carbon-containing dielectric on said barrier.

56. The method in claim 55, wherein said step of layering a carbon-free barrier on said substrate further comprises layering said carbon-free barrier using a plasma.

57. The method in claim 56, further comprising a step of heating said carbon-containing dielectric.

58. The method in claim 57, wherein said step of heating said carbon-containing dielectric comprises raising a temperature of said dielectric to a range of 850° C to 1050° C for at least 5 seconds.

59. The method in claim 57, wherein said step of heating said carbon-containing dielectric comprises raising a temperature of said dielectric to a range of 750° C to 1000° C for at least 5 minutes.

60. A method of processing a substrate comprising two active areas and an intervening insulating region, said method comprising:

depositing an oxide charge barrier over said substrate;
depositing a generally insulative material over said oxide charge barrier, wherein
said generally insulative material is less insulative than said barrier; and
providing a generally conductive element over said generally insulative material,
wherein said element is generally laterally coextensive with said intervening
insulating region.

61. The method in claim 60, wherein said step of depositing a generally insulative material comprises depositing a generally insulative material that is allowed to comprise oxide charges.

62. The method in claim 61, further comprising a step of plasma treating said substrate prior to said step of depositing an oxide charge barrier.

63. The method in claim 61, further comprising:

annealing said generally insulative material;
allowing an oxide charge in said generally insulative material to migrate toward
said substrate in response to said annealing step; and
intercepting said oxide charge with said oxide charge barrier before said oxide
charge reaches said substrate.

64. The method in claim 61, further comprising refraining from depositing any generally conductive material before said step of depositing a generally insulative material.

Appendix 2:
Amendment and Response to the Office Action dated 9/4/01

Serial No. 09/654,093

Inventor: Thakur et al.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Thakur et al.

Serial No.: 09/654,093

Filed: August 31, 2000

For: A METHOD TO AVOID THRESHOLD VOLTAGE SHIFT
IN THICKER DIELECTRIC FILMS

§
§ Group Art Unit: 2815
§
§ Examiner: P. Brock II
§
§ Atty. Docket: 94-0302.02
§
§
§
§

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Washington, D.C. 20231

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Signature

AMENDMENT AND RESPONSE TO THE
OFFICE ACTION DATED SEPTEMBER 4, 2001

Dear Sir:

Applicants submit this Amendment and Response to the Office Action of September 4, 2001. please amend the above-captioned application as follows.

IN THE CLAIMS

Please amend the claims to the form indicated below.

52. (Once amended) A method of processing a semiconductor device, comprising:

depositing a dielectric layer over a semiconductor substrate, said substrate comprising a plurality of electrically conductive regions and an electrically insulative region therebetween;

allowing electrically chargeable particles to occur in said dielectric layer;

allowing some diffusion of said electrically chargeable particles; and

preventing at least some of said electrically chargeable particles from reaching said substrate.

53. (Once amended) A method of processing a semiconductor device, comprising:

depositing a dielectric layer over a semiconductor substrate, wherein said step of depositing a dielectric layer comprises depositing a dielectric layer using a organic precursor;

allowing electrically chargeable particles to occur in said dielectric layer, wherein said step of allowing electrically chargeable particles to occur in said dielectric layer comprises allowing an organic component of said organic precursor to deposit in said dielectric layer;

allowing some diffusion of said electrically chargeable particles; and

preventing at least some of said electrically chargeable particles from reaching said substrate, wherein said preventing step comprises layering a barrier over said substrate using a non-organic precursor prior to said step of depositing a dielectric layer.

A marked-up version of these claims appears in Appendix 1 of this Amendment and Response.

REMARKS

Claims 52-64 are pending.

Claims 52-64 are rejected.

Claims 52-53 are amended

Applicants request the reconsideration of claims 52-64.

I. Rejection of claim under §112

Claim 60 refers to a “generally insulative material” and a “generally conductive element” that is “generally laterally coextensive” with an intervening insulating region. The Examiner argued that the term “generally” lacks support in the Specification and that one of ordinary skill

in the art would not be reasonably apprised of the scope of the invention given that term. As a result, the Examiner found the claim to be indefinite. Applicants contend that the Examiner is wrong on both counts. Concerning the phrase "generally insulative material," one of ordinary skill in the art would define an insulator to be

[a] material that, *ideally*, conducts no electricity; it can therefore be used for isolation and protection of energized circuits and components Actually, *no insulator is perfectly nonconductive*

(Gibilisco, THE ILLUSTRATED DICTIONARY OF ELECTRONICS (6th ed. 1994)(defining the term "insulator")(emphasis added). A copy of the relevant page of the DICTIONARY is included in Appendix 2 of this Amendment and Response.) Thus, one of ordinary skill in the art would understand that the term "generally" as used in the phrase "generally insulative material" acknowledges the lack of an ideal and perfect insulator. Moreover, the Specification provides non-limiting yet supporting examples of a "generally insulative material" in the form of a dielectric layer incorporating an oxide charge and a contaminant; wherein the dielectric layer may be BPSG, BSG, PSG, or silicon dioxide; the oxide charge may be positive or negative; and the contaminant may be carbon. As a result, the Specification provides further guidance to one of ordinary skill in the art as to what a "generally insulative material" may be.

Similarly, concerning the phrase "generally conductive element," one of ordinary skill in the art would define a conductor to be a "material which conducts electricity with *ease*." (DICTIONARY (defining the term "conductor")(emphasis added). A copy of the relevant page of the DICTIONARY is included in Appendix 2 of this Amendment and Response.) Based on this definition, one of ordinary skill in the art accepts that a conductor is a material that *easily* conducts electricity. Applicants contend that claim 60's use of the term "generally" is no less definite than the term "easily," which is considered to be sufficiently definite in the art. Further, such an artisan would understand that "[v]arious materials *vary widely* in their suitability as conductors." (*Id.*) Therefore, such an artisan understands that the term "generally" as used in the phrase "generally conductive element" also acknowledges the wide variance of conductivity exhibited by various materials.

As for claim 60's generally conductive element being "generally laterally coextensive" with an intervening insulating region, Applicants contend that non-limiting support for that term

may be found in FIGS. 1 and 3 of the Application and the Specification's text describing those figures, wherein a lead 26 is above an insulating region 14 yet, as the cross-sections illustrate, need not extend laterally to the same mathematically exact degree as does the insulating region 14. Guided by such disclosure, Applicants assert that one of ordinary skill in the art would understand the term "generally" as used in the phrase "generally laterally coextensive"

As a second basis for rejecting claim 60 under §112, the Examiner argued that its term "intervening insulating region" lacked antecedent basis. The proper antecedent basis may be found in claim 60's preamble, which refers to "an" intervening insulating region.

II. Rejection of claim under §102

The Examiner rejected claim 52 as being anticipated by Doan (U.S. Patent 5,372,974). Applicants have amended claim 52 to clarify its distinction from the matters disclosed in Doan. Specifically, claim 52 requires depositing a dielectric layer over a semiconductor substrate, the substrate *comprising a plurality of electrically conductive regions and an electrically insulative region therebetween*. Applicants contend that Doan fails to disclose such a limitation and therefore fails to anticipate claim 52.

III. Rejection of claims under §103

The Examiner rejected various groups of claims based on various combinations of references. Applicants address each basis for rejection separately below.

A. Rejection of claims based on Doan and Cunningham

The Examiner rejected claims 53-57 as obvious in light of Doan in combination with Cunningham (U.S. Patent 5,468,689). However, an obviousness rejection requires that the multiple prior art references suggest to one of ordinary skill in the art to combine the references. (*See United States Surgical Corp. v. Ethicon Inc.*, 103 F.3d 1554, 1564, 41 U.S.P.Q.2d 1225, 1233 (Fed. Cir. 1997), *cert. denied*, 522 U.S. 950 (1997).) Further, when the prior art contains conflicting references, the ability of each reference to suggest solutions to one of ordinary skill in

the art must be considered. (*See In re Young*, 927 F.2d 588, 18 U.S.P.Q. 1089 (Fed. Cir. 1991).) (Copies of these cases are included in Appendix 3 to this Amendment and Response.) Applicants contend that while the Examiner attempted to present a motivation for combining Doan and Cunningham, those references conflict with each other so greatly that any motivation to combine is untenable. In fact, the references motivate one of ordinary skill in the art to avoid their combination.

Cunningham, for instance, touts concern over material cracking during reflow. (Cunningham at col. 1, ln. 45-53.) As a result, Cunningham teaches providing a nitride barrier 14 over its "top" layer 13. (*Id.*; see also col. 3, ln. 21-38; FIG. 1.) Significantly, however, Cunningham does not provide its nitride barrier between layers that comprise its stack. (*Id.*) Thus, one of ordinary skill in the art is lead to believe that there is no need for such a barrier in those location and hence, no cracking issues there.

On the other hand, Doan, which also expresses concern over material cracking during reflow, indicates that cracking between layers of the stack is a major problem. Specifically, Doan teaches providing a nitride barrier between each and every layer of its stack. (Doan at col. 4, ln 28- col. 5, ln. 9; FIGS. 6-7.) Thus, in light of Cunningham, Doan appears to one of ordinary skill in the art to require unnecessary redundancy in terms of barrier layers, thereby adding unnecessary time, money, and effort to the fabrication process. Conversely, in light of Doan, Cunningham appears to the artisan to leave its device susceptible to the very cracking problem Cunningham seeks to avoid. Given such fundamental conflicts, Applicants assert that the references lack the ability to suggest solutions to one of ordinary skill in the art and in fact discourage their combination. Thus, without a legally proper motivation to combine, the obviousness argument against claims 53-57 fails. Accordingly, the only amendment to claim 53 has been to put it in independent form by expressing the limitations originally presented in claim 52.

B. Rejection of claims based on Doan, Cunningham, and Ying

The Examiner rejected claims 58 and 59 as obvious in light of Doan and Cunningham in combination with Ying (U.S. Patent 5,384,288). In fact, the Examiner's reasoning is essentially the same as that used to reject these claims in the last office action, based on the combination of

Doan and Ying alone. (Office Action dated 1/26/01 at p. 3-4.) In response to the prior rejection, Applicants pointed out the inconsistencies between Doan and Ying that would discourage combination. (Amendment and Response submitted 7/26/01.) Applicants contend that their earlier argument, which need not be repeated here, applies equally to the current rejection and that adding Cunningham to the combination does not cure the fundamental conflicts between Doan and Ying.

In fact, adding Cunningham exacerbates the conflicts between the references in the attempted combination. As discussed in part (A) above, Doan and Cunningham also conflict on a fundamental level, indicating a further lack of their ability to suggest solutions to one of ordinary skill in the art and further discouraging the proposed Doan/Cunningham/Ying combination. In addition, Cunningham and Ying also conflict. Significantly, the processes taught in both references require a barrier material such as a nitride. Cunningham requires that its nitride barrier 14 expose a portion of a silicon substrate 10 in order to grow GaAs thereon. (Cunningham at col. 3, ln. 21-38; FIG. 1.) Ying, on the other hand, requires that its nitride barrier 14 expose none of the substrate 10 in order to protect the substrate 10 from subsequent process. (Ying at col. 3, ln. 18-28; FIGS. 1A-1C.) Thus, one of ordinary skill in the art attempting to combine the references would achieve a Cunningham-type device with a continuous nitride barrier that covers the substrate and hinders the desirable growth of GaAs. Alternatively, the artisan would achieve a Ying-type device having a nitride barrier that exposes the substrate, thereby allowing undesirable deterioration during subsequent processing. Either combination is unworkable and hence provides further discouragement in attempting a Doan/Cunningham/Ying combination.

C. Rejection of claims based on Doan and Ghezzi

The Examiner rejected claims 60-61 and 63-64 as being obvious in light of Doan in combination with Ghezzi (U.S. Patent 5,132,239). In fact, the Examiner's reasoning is the same as that used to reject these claims in the last office action. (Office Action dated 1/26/01 at p. 4-5.) Applicants responded to the rejection, pointing out the inconsistencies between Doan and Ghezzi that would discourage combination. (Amendment and Response submitted 7/26/01.) Applicants contend that their earlier argument, which need not be repeated here, applies equally to the

current rejection. In the latest Office Action, the Examiner failed to consider the conflicts between the references highlighted by Applicants, as required by the rule in *Young* (18 U.S.P.Q. 1089). Moreover, the Examiner admitted that hindsight was used to determine obviousness, and claimed that other case precedent justified that action.

Specifically, the Examiner cited *In re McLaughlin* (443 F.2d 1392, 170 U.S.P.Q. 209 (C.C.P.A. 1971)) for support. However, *McLaughlin* actually favors Applicants in that it highlights the Examiner's failure to meet the *prima facie* burden for this and all of the other obviousness rejections. *McLaughlin* emphasizes that, in considering whether to combine references for an obviousness rejection, the Examiner must consider what the references "*taken as a whole* would suggest to one of ordinary skill in the art." (*McLaughlin*, 170 U.S.P.Q. at 212 (emphasis added).) Applicants assert that considering the references as a whole necessitates more than merely focusing on their points that may arguably support an obviousness rejection; rather, it further requires considering the conflicts between the references, as required by *Young*. The Examiner failed to address such conflicts, either in the first Office Action (dated 1/26/01) or, after being reminded by Applicants, in the last Office Action. Hence, the Examiner has failed to satisfy the standards set forth by the very case precedent cited by the Examiner.

Moreover, the Examiner's failure to address the conflicts between the references suggests that the Examiner has ignored those conflicts and somehow been able to focus on certain aspects of the references that justify, in the Examiner's mind, the rejection of the relevant claims. Applicants submit that the guidance for such focus can only come from the current application. In using the current application in such a manner, the Examiner has violated another tenet of *McLaughlin*, which requires that the "[j]udgment on obviousness . . . not include knowledge gleaned only from applicant's disclosure." (*McLaughlin*, 170 U.S.P.Q. at 212.) Thus, the conflicts within the Doan/Ghezzi combination and the Examiner's failure to address those conflicts warrant a withdrawal of any rejection relying on that combination.

D. Rejection of claim based on Doan, Ghezzi, and Van Der Scheer

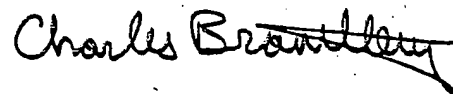
The Examiner rejected claim 62 as being obvious in light of Doan and Ghezzi in combination with Van Der Scheer (U.S. Patent 4,976,856). As with the rejection addressed in part (C) above, the Examiner raised essentially the same rejection and offered the same

supporting argument in the last office action as in the first Office Action. (See Office Action dated 1/26/01 at p. 6.) As a further parallel with part (C), Applicants responded to the rejection, pointing out the inconsistencies between the references. Specifically, Applicants noted that each reference in the proposed combination conflicts with the other two references in the combination. Applicants contend that the response still supports the patentability of the claim yet will not repeat the arguments here to avoid redundancy. This is especially appropriate as – just as in part (C) above – the Examiner has still failed to consider those conflicts in attempting to address the motive to combine. Accordingly, the consequences and result are the same here as in part (C): the Examiner's failure to address the conflicts between the references suggests that the Examiner has failed to consider the references as a whole, ignored those conflicts, and been able to focus on certain aspects of the references based on knowledge gleaned from the current application; thus, the Examiner's conduct fails to satisfy the standards set forth in *McLaughlin* and *Young*, which warrants a withdrawal of this rejection.

CONCLUSION

In light of the above remarks, Applicants submit that claims 52-64 are allowable over the applied references. Therefore, Applicants respectfully request reconsideration of the Examiner's rejections and further requests allowance of all of the pending claims. If there are any matters which may be resolved or clarified through a telephone interview, the Examiner is requested to contact Applicants' undersigned attorney at the number indicated.

Respectfully submitted,



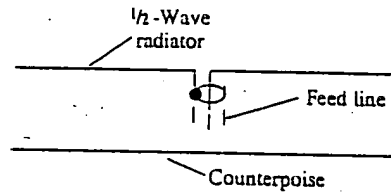
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Attorney for Applicants

Appendix 1: Marked-up version of amended claims

52. (Once amended) A method of processing a semiconductor device, comprising:
- depositing a dielectric layer over a semiconductor substrate, said substrate comprising a plurality of electrically conductive regions and an electrically insulative region therebetween;
 - allowing electrically chargeable particles to occur in said dielectric layer;
 - allowing some diffusion of said electrically chargeable particles; and
 - preventing at least some of said electrically chargeable particles from reaching said substrate.
53. (Once amended) [The method in claim 52, wherein:] A method of processing a semiconductor device, comprising:
- depositing a dielectric layer over a semiconductor substrate, wherein said step of
 - depositing a dielectric layer comprises depositing a dielectric layer using a organic precursor;
 - allowing electrically chargeable particles to occur in said dielectric layer, wherein said
 - step of allowing electrically chargeable particles to occur in said dielectric layer comprises allowing an organic component of said organic precursor to deposit in said dielectric layer;
 - allowing some diffusion of said electrically chargeable particles; and
 - preventing at least some of said electrically chargeable particles from reaching said
 - substrate, wherein said preventing step comprises layering a barrier over said
 - substrate using a non-organic precursor prior to said step of depositing a dielectric
 - layer.

Appendix 2

Gibilisco, THE ILLUSTRATED DICTIONARY OF ELECTRONICS (6th ed. 1994)(defining the terms
“conductor” and “insulator”)



condenser antenna

making the output current alternate accordingly. Also called *capacitor microphone*.

condensing routine A computer program that takes an object (user written) program from an internal or external memory to punched cards in a way that maximizes the cards' storage capacity.

condensite A plastic insulating material whose base is phenol formaldehyde resin.

conditional Dependent on some external factor, and therefore subject to change.

conditional branch The point in a computer program where a relational test is performed and the statement line in which the test is made is left so that an out-of-sequence instruction can be implemented. Such a branch might be made, for example, following the BASIC statement "if Z = Y then go to (another line in the program)."

conditional branch instruction The instruction in a computer program that causes a conditional branch.

conditional implication operation A Boolean operation in which the result of operand values *a* and *b* are such that the output is high only if input *a* is high and input *B* is low. Also called *inclusion, if-then operation*.

conditional jump See **CONDITIONAL BRANCH**.

conditional stop instruction In a computer program, an instruction that can cause a halt in the run, as dictated by some specified condition.

conditional transfer See **CONDITIONAL BRANCH INSTRUCTIONS**.

condition code A set of constraints for a computer program. The condition code sets the limits on what can be done with the computer under certain circumstances.

conditioning 1. The process of making equipment compatible for use with other equipment. Generally involves some design or installation changes. 2. Interfacing.

Condor A continuous-wave navigational system giving a cathode-ray-tube display for automatically determining the bearing and distance from a ground station. Compare **BENITO**.

conductance Symbol, *G*. Unit, siemens. The ability of a circuit, conductor, or device to conduct electricity. Conductance is the reciprocal of resistance $G = 1/R = I/E$.

conducted heat Heat transferred by conduction through a material substance, as opposed to convection (movement of matter) and radiation (which

occurs through empty space). A heat sink conducts dissipated energy away from a transistor, for example.

conducting layer See **KENNELLY-HEAVISIDE LAYER**.

conduction 1. The propagation of energy through a medium, depending on the medium for its travel. 2. The transfer of electrons through a wire. 3. The transfer of holes through a P-type semiconductor material. 4. Heat transfer through a material object (see **CONDUCTED HEAT**).

conduction angle See **ANGLE OF CONDUCTION**.

conduction band In the arrangement of energy levels within an atom, the band in which a free electron can exist; it is above the valence band in which electrons are bound to the atom. In a metallic atom, conduction and valence bands overlap; but in semiconductors and insulators, they are separated by an energy gap.

conduction current 1. The electromagnetic-field flow that occurs in the direction of propagation. A measure of the ease with which the field is propagated. 2. Current in a wire or other conductor.

conduction-current modulation In a microwave tube, cyclic variations in the conduction current; also, the method of producing such modulation.

conduction electron See **FREE ELECTRON**.

conduction error In a temperature-acutated transducer, error caused by conduction of heat between the sensor and the mounting.

conduction field An energy field that exists in the vicinity of an electric current.

conductive coating A conducting layer applied to the glass envelope of a cathode-ray tube, such as an oscilloscope tube or picture tube. Also see **AQUADAG**.

conductive coupling See **DIRECT COUPLING**.

conductive material See **CONDUCTOR**.

conductive pattern The pattern of conductive lines and areas in a printed circuit.

conductivity Symbol, Σ . Unit, S/m (siemens per meter). Specific conductance, i.e., conductance per unit length. Conductivity is the reciprocal of resistivity: $\Sigma = 1/\rho$.

conductivity meter A device for measuring electrical conductivity. Generally, such a device is calibrated in mhos.

conductivity modulation In a demiconductor, the variation in conductivity resulting from variation of charge-carrier density.

conductivity-modulation transistor A transistor in which the bulk resistivity of the semiconductor material is modulated by minority carriers.

conductor 1. A material which conducts electricity with ease, such as metals, electrolytes, and ionized gases. Various materials vary widely in their suitability as conductors; the conductivity of commercial copper, for example, is almost twice that of aluminum. Compare **INSULATOR**. 2. An individual conducting wire in a cable, insulated or uninsulated.

conduit A hollow tube, made of plastic or metal,

- insulated-gate field-effect transistor** Abbreviation, IGFET. See METAL-OXIDE SILICON FET.
- insulated resistor** A resistor around which is molded a nonconducting material, such as vitreous enamel or a plastic.
- insulating tape** Electrical insulation in the form of a thin, usually adhesive, strip of fabric, paper, or plastic.
- insulation** 1. A coating of dielectric material that precludes a short circuit between a conductor and the surrounding environment. 2. The application of a dielectric coating to an electrical conductor. 3. Electrical separation between or among different components, circuits, or systems.
- insulation breakdown** Current leakage through, and rupture of, an insulating material because of high voltage stress.
- insulation ratings** Collectively, the dielectric constant, dielectric strength, power factor, and resistivity of an insulating material. Sometimes included are such physical properties as rupture strength, melting point, and so on.
- insulation resistance** The very high resistance exhibited by a good insulating material. It is expressed in megohms (or higher units of resistance) for a sample of material of stated volume or area.
- insulation system** Collectively, the materials needed to insulate a given electronic device.
- insulator** 1. A material that, ideally, conducts no electricity; it can therefore be used for isolation and protection of energized circuits and components (*also see* DIELECTRIC). Actually, no insulator is perfectly nonconductive (*see, for example, INSULATION RESISTANCE*). 2. Any body made from an insulating material.
- insulator arcover** A sudden arc, or flow of current, over the surface of an insulator, because of excessive voltage.
- integer** A whole number, as opposed to a fraction or mixed number.
- integral** 1. Symbol, \int . The sum of an infinite series of values (increments) making up a quantity. Thus, $\int dx = x$. Compare DIFFERENTIAL. *Also see* DEFINITE INTEGRAL, INDEFINITE INTEGRAL, INTEGRAL CALCULUS, and INTEGRATION. 2. The part of a number to the left of the radix point.
- integral action** In automatic control practice, a control action delivering a corrective signal proportional to the time the controlled quantity has differed from a desired value.
- integral calculus** The branch of mathematics concerned with the theory and applications of integration. *Also see* DEFINITE INTEGRAL; INDEFINITE INTEGRAL; INTEGRAL; INTEGRATION. Like differential calculus, integral calculus is a powerful tool in electronics design.
- integral contact** In a relay or switch, a contact that carries current to be switched.
- integral-horsepower motor** A motor rated at 1 horsepower.
- integral multiple** A whole multiple of a number. Thus, a harmonic is an integral multiple of a fundamental frequency f , $2f$, $5f$, $10f$, and so on.
- integral number** See INTEGER.
- integrand** A function or equation which is to be integrated. Thus, in the integral expression $\int y dx$, the integrand is $y dx$. *Also see* INTEGRAL; INTEGRAL CALCULUS; INTEGRATION.
- integrate** 1. To perform the function of mathematical or electrical integration. 2. To construct a circuit on a piece of semiconductor material.
- integrated** Constructed on a single piece of material, such as a semiconductor wafer.
- integrated amplifier** An AF amplifier having a preamplifier, intermediate amplifier, and output amplifier on a single chassis.
- integrated capacitor** In an integrated circuit, a fixed capacitor in which one "plate" is a layer of material diffused into the substrate; the dielectric, a thin oxide film grown on top of the first layer; and the other plate, a metal layer deposited on top of the oxide film.
- integrated circuit** Abbreviation, IC. A circuit whose components and connecting "wires" are made by processing distinct areas of a chip of semiconductor material, such as silicon. Integrated circuits are classified according to construction, a few being monolithic, thin-film, and hybrid.
- integrated data processing** Abbreviation, IDP. The detailed electronic classification, sorting, storage, and mathematical processing of data within a coordinated system of equipment, usually at one location.
- integrated electronics** That branch of electronics that is concerned with the design and fabrication of integrated circuits.
- integrated resistor** See DIFFUSED-LAYER RESISTOR.
- integrating circuit** See INTEGRATING NETWORK.
- integrating galvanometer** A device for measuring the change in electric flux produced in a coil in an electric field. Even very slow changes can be measured.
- integrating meter** An instrument whose indication is a summation (usually) of an electrical quantity that is time-dependent, e.g., ampere-hour meter, watt-hour meter.
- integrating motor** An electric motor that follows the integral of the input signal. The angle of rotation of the motor shaft is equal to the integral of an input waveform.
- integrating network** A four-terminal RC network (series resistor, shunt capacitor) whose output voltage is (or is proportional to) the time integral of the input voltage. Compare DIFFERENTIATING NETWORK.
- integrating photometer** An indicating photometer whose reading is the average candlepower at all angles in one plane.
- integration** Finding a function when its derivative is given. Integration is the inverse of differentia-

Appendix 3:

Miles Laboratories Inc. v. Shandon Inc., 997 F.2d 870, 27 U.S.P.Q.2d 1123 (Fed. Cir. 1993), *cert. denied*, 510 U.S. 1100 (1994).

▷

Miles Laboratories Inc.
v.
Shandon Inc.

Court of Appeals, Federal Circuit

Nos. 92-1358, -1357

Decided June 14, 1993

United States Patents Quarterly Headnotes

JUDICIAL PRACTICE AND PROCEDURE

[1] Procedure -- Judicial review -- Standard of review -- Patents (Section 410.4607.09)

Appellate review of federal district court's findings of fact in patent infringement action is under "clearly erroneous" standard, and district court's legal conclusions will be accepted unless incorrect as matter of law; appellate court will not reverse simply because it would have decided case differently.

PATENTS

[2] Patentability/Validity -- Specification -- In general (Section 115.1101)

"Distinctly claiming" requirement of 35 USC 112, paragraph 2, means that claims must have clear and definite meaning when construed in light of complete patent documents; test for definiteness is whether one skilled in art would understand bounds of claim when read in light of specification, and degree of precision necessary for adequate claims depends upon nature of subject matter.

PATENTS

[3] Infringement -- Construction of claims (Section 120.03)

JUDICIAL PRACTICE AND PROCEDURE

Procedure -- Judicial review -- Standard of review -- Patents (Section 410.4607.09)

Claim interpretation, as first step in two-part determination of whether infringement occurred, proceeds as question of law, but if trial court resolves factual disputes underlying meaning of claim terms, then those findings are reviewed on appeal under "clearly erroneous" standard.

PATENTS

[4] Infringement -- Construction of claims (Section 120.03)

Infringement -- Literal infringement (Section 120.05)

Patent construction -- Claims -- Defining terms (Section 125.1305)

Federal district court, in considering claims for light microscopy processing apparatus, properly construed term "cabinet" to mean single enclosure for various parts of apparatus, but court clearly erred in finding that accused device, which consists of three cabinets, literally infringes single cabinet limitation of patent in suit.

PATENTS

[5] Infringement -- Doctrine of equivalents -- In general (Section 120.0701)

Federal district court did not err in determining that accused device for light microscopy processing apparatus infringed under doctrine of equivalents, even though defendant contends that intended result of patent in suit is unification of various components in single cabinet, while accused device achieves safety and operational advantages by separating components, since infringement under doctrine of equivalents does not vanish merely because accused device performs functions in addition to those performed by claimed device, since accused device, regardless of its separation of components into modules, still achieves substantially same result as patent in suit, and since allowing defendant to escape infringement simply through its use of separate cabinets would cause injustice that doctrine of equivalents is designed to prevent.

PATENTS

[6] Patentability/Validity -- Obviousness -- Secondary considerations generally (Section 115.0907)

Objective indicia of non-obviousness weigh in favor of finding of non-obviousness, although lack of such evidence does not weigh in favor of obviousness.

PATENTS

[7] Patentability/Validity -- Obviousness -- Relevant prior art -- Particular inventions (Section 115.0903.03)

Federal district court did not err in finding claims for light microscopy processing method to be invalid for obviousness, in view of evidence demonstrating that differences between prior art and patent in suit were minor and achievable by simple modification, and demonstrating that prior art references collectively suggest engineering necessary to achieve these modifications, and in view of plaintiff's failure to show any objective indicia of non-obviousness.

PATENTS

Particular patents -- General and mechanical -- Light microscopy

Re. 29,073 (3,892,197), Kinney and Pickett, light microscopy processing apparatus, holding of validity and infringement affirmed.

PATENTS

Particular patents -- Chemical -- Light microscopy

4,001,460, Kinney and Pickett, light microscopy processing method, holding of invalidity affirmed.

***1124** Appeal from the U.S. District Court for the Western District of Pennsylvania, Diamond, J.

Action by Miles Laboratories Inc. and Triangle Biomedical Equipment Inc. against Shandon Inc. and Shandon Southern Products Limited, for patent infringement. From federal district court decision holding one patent in suit invalid for obviousness, and holding other patent valid and affirmed, parties cross-appeal. Affirmed.

Arnold Sprung, of Sprung Horn Kramer & Woods (Nathaniel D. Kramer, with him on brief), Tarrytown, N.Y., for plaintiffs.

Robert D. Yeager, of Kirkpatrick & Lockhart (Christine R. Ethridge and Melvin C. Snyder, III, with him on brief), Pittsburgh, Pa., for defendants.

Before Smith, senior circuit judge, and Plager and Rader, circuit judges.

Rader, J.

Miles Laboratories, Inc. and Triangle Biomedical Equipment, Inc. sued Shandon Inc. and Shandon Southern Products Limited, for infringement of U.S. Patent Reissue No. 29,073, entitled "Light Microscopy Processing Apparatus" ('073), [FN251] and U.S. Patent No. 4,001,460, entitled "Light Microscopy *1125 Processing Method" ('460). The United States District Court for the Western District of Pennsylvania held claims 1, 2, and 4-7 of the '460 patent invalid for obviousness, sustained the validity of the '073 patent, and found infringement of both patents. Miles Lab., Inc. v. Shandon, Inc., No. 86-2404 (W.D. Pa. Mar. 11, 1992) (Miles I); Miles Lab., Inc. v. Shandon, Inc., No. 86-2404 (W.D. Pa. Apr. 14, 1992) (Miles II). Because the record adequately supports the district court's decision, this court affirms.

BACKGROUND

Tissue processing is the treatment of tissue specimens to facilitate viewing them under a microscope. The process exposes the tissue specimens to a series of chemical solutions (reagents) in sequence. The '460 patent claims a method and the '073 patent an apparatus for tissue processing. Except for the claims, the two patents have identical specifications.

Under the method accomplished by the apparatus, a central processing chamber confines the tissue specimens under a sealed cover where they remain fixed during treatment with various fluids and paraffin. Once embedded in paraffin, the specimens can be sliced into very thin sections for microscopic viewing. The treatment takes place when a vacuum draws the fluids and paraffin into the central chamber. After proper exposure, pressure in the central chamber expels the fluids back to their storage containers. Thus, the entire processing occurs without tampering with the tissue specimens.

In 1986, Miles sued Shandon for infringement of both patents. The district court held a bench trial in 1988. The district court determined that the doctrine of laches did not bar this action and that claim 1 of the '460 patent was invalid under 35 U.S.C. Section 103. Miles I, slip op. at 30. The district court also upheld the validity of the '073 patent and found infringement of both patents. Id.

Later, the district court clarified its earlier decision and added the '460 patent's dependent claims 2 and 4-7 to its obviousness ruling. Miles II, slip op. at 1. In addition, the district court enjoined Shandon from further infringement of the '073 patent. Id. Shandon appeals the validity determination on the '073 patent and the infringement rulings. Miles cross-appeals the invalidity determination on the '460 patent.

DISCUSSION Standard of Review

This court reviews the district court's fact finding under the "clearly erroneous" standard of Rule 52(a):

Findings of fact, whether based on oral or documentary evidence, shall not be set aside unless clearly erroneous, and due regard shall be given to the opportunity of the trial court to judge of the credibility of the witnesses.

Fed. R. Civ. P. 52(a) (1988); see *Heisig v. United States*, 719 F.2d 1153, 1158 (Fed. Cir. 1983). This court accepts the legal conclusions of the district court unless incorrect as a matter of law. Id.

[1] This court does not review de novo proceedings of the district court. *Medtronic, Inc. v. Daig Corp.*, 789 F.2d 903, 904, 229 USPQ 664, 666 (Fed. Cir.), cert. denied, 479 U.S. 931 (1986). To win reversal, a party must show that the district court committed reversible legal error or relied upon factual findings which were clearly erroneous in light of the trial record. *Id.* at 904-05. In addition, the "clearly erroneous" standard does not entitle this court to reverse the district court's finding simply because it would have decided the case differently. *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1375, 231 USPQ 81, 87 (Fed. Cir. 1986), cert. denied, 480 U.S. 947 (1987). Where the factfinder's account of the evidence is plausible in light of the entire record or where it chooses one of two permissible views of the evidence, it has committed no clear error. *Id.*

The '073 Patent

On the last day of trial, Shandon moved to introduce an infringement defense that the '073 patent was invalid for indefiniteness under 35 U.S.C. Section 112, Para. 2 (1988). The district court, however, upheld the validity of the '073 patent. On appeal, Shandon alleges the claims of the '073 patent omit the requirement for "vented" solution containers and therefore do not distinctly claim the disclosed invention.

Validity

[2] Shandon challenged the claims of the '073 patent as indefinite under Section 112, Para. 2. Compliance with Section 112, Para. 2 is a question of law. *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1576, 1 USPQ2d 1081, 1088 (Fed. Cir. 1986). Section 112, paragraph 2, states:

***1126** The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

35 U.S.C. Section 112, Para. 2. The "distinctly claiming" requirement means that the claims must have a clear and definite meaning when construed in the light of the complete patent document. *Standard Oil Co. v. American Cyanamid Co.*, 774 F.2d 448, 452, 227 USPQ 293, 296 (Fed. Cir. 1985). Section 112 thus ensures definiteness of claim language. See *In re Zletz*, 319, 322, 13 USPQ2d 1320, 1322 (Fed. Cir. 1989).

The test for definiteness is whether one skilled in the

art would understand the bounds of the claim when read in light of the specification. *Orthokinetics*, 806 F.2d at 1576. If the claims read in light of the specification reasonably apprise those skilled in the art of the scope of the invention, Section 112 demands no more. *Hybritech*, 802 F.2d at 1385. The degree of precision necessary for adequate claims is a function of the nature of the subject matter. *Id.*

At trial, a Miles expert, Mr. Kocsis, stated:

Q Now, reading these claims [of the '073 patent], which we have just discussed, did you see any mention in any of these claims of vented containers or reagent bottles, or anything like that?

A No, I did not.

....

Q Now, that single machine, as described in the '460 and '073 patents, requires that a vent to atmosphere be present in each solution container in order for the machine to transfer solutions from a solution container to a processing chamber and back, is that correct?

A That's correct.

Relying on these isolated statements, Shandon contends that the claims do not specify vented solution containers. Without vented containers, Shandon contends, the claims do not describe a workable invention. Without vents, Shandon asserts, the invention cannot change pressure to draw fluids into and out of the central treatment chamber.

Shandon's argument is irrelevant to definiteness under Section 112, Para. 2. The invention's operability may say nothing about a skilled artisan's understanding of the bounds of the claim. Shandon's argument is possibly relevant, however, to the enablement requirement of Section 112, Para. 1, or to utility under Section 101.

Construed as a challenge to utility or enablement, Shandon's argument nevertheless fails. Mr. Kocsis testified that the claimed tissue processors would operate with or without vents in the solution containers. Without vents, collapsible solution containers could permit the transfer of fluids by pressure changes. The district court correctly concluded that "the record shows that even unvented containers would be operative." *Miles II*, slip op. at 4. Thus Shandon did not show a lack of utility, even if the claims cover only unvented containers.

The trial court also determined that the claims, read in light of the specification, covered both unvented containers and vented containers. In fact, the preferred embodiment described in the specification discloses "vented" solution containers:

Referring again to FIG 3, the previously referred to solution containers 15 (with operating numbers 1 through 10) have respective caps 55 for refilling the containers. Suitable air vents 56, indicated by dashed lines, are provided in each cap 55, but are preferably kept extremely small so as to limit any admission of moisture.

Col. 6, lines 3-9. Therefore, the claims read in light of the specification reasonably apprise those skilled in the art of the claimed invention. Moreover, the record shows that the patent disclosed adequate information to enable a skilled artisan to make and use the claimed invention. *Northern Telecom, Inc. v. Datapoint Corp.*, 908 F.2d 931, 941, 15 USPQ2d 1329 (Fed. Cir.), cert. denied, 498 U.S. 920 (1990).

Appellant incorrectly characterized its validity challenge as a claim definiteness issue -- a characterization which the district court followed, at least in name. Nonetheless, the district court made proper findings and correctly concluded that appellant did not rebut the presumed validity of the claims.

Infringement

The district court determined that the accused devices, known as the HYPERCENTER and the HYPERCENTER 2, infringed the '073 patent literally, or in the alternative, under the doctrine of equivalents. *Miles I*, slip op. at 28-30. On appeal, Shandon argues that the district court misconstrued the "cabinet" limitation of the claims.

[3] This court reviews a trial court's infringement findings under the "clearly erroneous" standard. *Charles Greiner & Co. v. Mari-Med Mfg., Inc.*, 962 F.2d 1031, 1034, 22 USPQ2d 1526, 1528 (Fed. Cir. 1992); *Insta-Foam Prods., Inc. v. Universal Foam Sys., Inc.*, 906 F.2d 698, 702, 15 USPQ2d 1295, 1297 (Fed. Cir. 1990). Claim interpretation *1127 is the first step in the two-part infringement determination. *Greiner*, 962 F.2d at 1034. Claim interpretation proceeds as a question of law. *Id.* When a trial court, however, resolves factual disputes underlying the meaning of claim terms, this court reviews these findings under the clearly erroneous standard. *Id.* In interpreting disputed claim terms, the

trial court considers the specification and the prosecution history. *Id.* After interpreting the claim, the final step of the infringement analysis determines whether the accused device is within the scope of the claim. *Id.* To infringe, an accused device must embody exactly each claim limitation or its equivalent. *Id.*

The district court determined that the HYPERCENTERS contained every limitation set forth in claim 1 of the '073 patent. *Miles I*, slip op. at 28. In reaching this conclusion, the district court construed the cabinet limitation of claim 1 to define an enclosure for the various elements of the processing apparatus. *Id.* The court also determined that the HYPERCENTERS consisted of three modules: a module which housed the operating controls, a module which housed the reagent storage bottles, and a module which contained the central processing chamber and the paraffin baths. The district court concluded that the separate modules of the HYPERCENTER collectively formed a cabinet. *Id.*

[4] The district court properly construed the term "cabinet" to mean a single enclosure for the various parts of the apparatus. The claims, specification, and drawings disclose a single cabinet enclosing the tissue processing apparatus. The embodiment illustrated in the patent specification disclosed a single cabinet comprised of a number of sections, including numerous reagent bottles, a processing chamber, paraffin containers, and a control module. Moreover, Webster's defines "cabinet" as "1 a case or cupboard with drawers or shelves for holding or storing things . . . 2 a boxlike enclosure." Webster's New World Dictionary, 193 (3d col. ed. 1988).

The HYPERCENTERS, however, consist of three modules as opposed to one. "Module" is defined as "any of a set of units, as cabinets, designed to be arranged or joined in a variety of ways." Webster's at 872. Because three does not equal one, the district court clearly erred in finding that the HYPERCENTERS (consisting of three cabinets) literally infringed the single cabinet limitation of the '073 patent.

[5] This court, however, concludes that the district court did not err in determining that the HYPERCENTERS infringed the '073 patent under the doctrine of equivalents. Infringement under the doctrine of equivalents requires a showing that the accused device performs substantially the same function, in substantially the same way, to achieve

substantially the same result as the claimed device. *Malta v. Schulmerich Carillons, Inc.*, 952 F.2d 1320, 1325, 21 USPQ2d 1161, 1165 (Fed. Cir. 1991), cert. denied, 112 S. Ct. 2942 (1992) (citing *Graver Tank & Mfg. Co. v. Linde Air Prods. Co.*, 339 U.S. 605, 608 [85 USPQ 328] (1950)).

The doctrine of equivalents prevents the pirating of the patentee's invention in the absence of literal infringement when liability is nevertheless warranted. *Hormone Research Found., Inc. v. Genetech, Inc.*, 904 F.2d 1558, 1564, 15 USPQ2d 1039, 1044 (Fed. Cir. 1990). The doctrine of equivalents thus prevents the risk of injustice that may result from a limited focus on words alone. *Laitram Corp. v. Cambridge Wire Cloth Co.*, 863 F.2d 855, 856-57, 9 USPQ2d 1289, 1291 (Fed. Cir. 1988), cert. denied, 490 U.S. 1068 (1989).

Shandon argues that the district court did not determine that the HYPERCENTERS achieved "substantially the same result" as the '073 patent. Shandon contends that the intended result of the '073 patent is unification of the various components. Shandon alleges that HYPERCENTERS achieve safety and operational advantages by separating the components.

The '073 patent achieves an enclosed tissue processing system. The district court stated:

The '073 patent discloses an apparatus for fixing and processing the tissue specimens. It is an improvement over the prior art because it represents the first completely automatic system for allowing light microscopy tissue to be processed under a completely automatic sequence in an entirely closed system and without requiring substantial movement of the specimens.

Miles I, slip op. at 3-4 (citation omitted). This result does not change merely because Shandon separated certain components of the system into discrete modules.

In addition, the '073 patent does not specify that the cabinet contains all components of the invention. Rather claim 1 specifies an "air pump means . . . mounted proximate said cabinet." The '073 patent, col. 11, lines 17-19. Claim 1 also claims "electrical control means . . . mounted proximate said chamber." *Id.* col. 12, lines 1-3. Therefore, although *1128 claim 1 may have a cabinet limitation, not all components of the tissue processor must be within the cabinet. Indeed, the specification states that "the controls could be mounted

in a separate cabinet." *Id.* col. 10, lines 34-35.

The limitations and functions of the invention in the claims, not the elements or functions of the accused device, establish the reference point for the doctrine of equivalents. *Insta-Foam*, 906 F.2d at 702. Infringement under the doctrine does not vanish merely because the accused device performs functions in addition to those performed by the claimed device. *Id.* Regardless of separation into modules, Shandon's system is still a "completely automatic system for allowing light microscopy tissue to be processed under a completely automatic sequence in an entirely closed system and without requiring substantial movement of the specimens." See *Miles I*, slip op. at 3- 4. Thus, the HYPERCENTERS achieved substantially the same result as the '073 patent.

To allow Shandon to escape infringement simply because it used separate cabinets, as opposed to a single cabinet, is the exact type of injustice the doctrine of equivalents prevents. See *Laitram Corp.*, 863 F.2d at 856-57. This court discerns no clear error in the district court's finding of infringement under the doctrine of equivalents.

The '460 Patent

The district court held claim 1 of the '460 patent invalid for obviousness under 35 U.S.C. Section 103 (1988). *Miles I*, slip op. at 16-17. The district court later held the dependent claims of the '460 patent (claims 2, 4-7) invalid by virtue of claim 1's invalidity. *Miles II*, slip op. at 2.

35 U.S.C. Section 103 -- Obviousness

The ultimate legal conclusion of obviousness is a question of law. *Specialty Composites v. Cabot Corp.*, 845 F.2d 981, 989, 6 USPQ2d 1601, 1606 (Fed. Cir. 1988). The analysis of obviousness, however, rests on several factual inquiries: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; (3) the level of ordinary skill in the art at the time of invention; and (4) objective evidence of nonobviousness. *Id.* (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1960)). This court reviews these factual underpinnings for the legal conclusion of obviousness under the "clearly erroneous" standard. *Specialty Composites*, 845 F.2d at 989. The facts stated herein are based on district court findings not found to be clearly erroneous or otherwise not in dispute.

The prior art in this instance included U.S. Patent No. 3,526,203 (the '203 patent), U.S. Patent No. 3,227,130 (the Weiskopf patent), and the Lipshaw Manufacturing Corporation's "Fluid X Changer." The '203 patent covers an electron microscopy tissue processor. Electron microscopy differs from light microscopy in that the former requires only very small tissue specimens. With small tissue specimens, electron microscopy does not need to reuse processing reagents. Nonetheless, the specification of the '203 patent provides: "it will be apparent that the processor of the invention may be used for processing the larger sized tissue particles which are intended for light microscopy examination." *Miles I*, slip op. at 10 (quoting U.S. Patent No. 3,526,203, col. 8, lines 5-8). The claims of the '203 patent disclose the vacuum component of the '460 patent. Furthermore, the '203 patent suggests a solution to the problem resolved by claim 1 of the '460 patent, namely, a means of reusing a solution by returning unused quantities to the storage container with pressure.

The specification of the '203 patent provides:

In this regard it should be noted that the practice in electron microscopy work is not to reuse the solutions and in the system of the invention only fresh solution is transferred through the lines and valves connecting the containers with the processing chamber. If the particular solutions are required to be pumped back to the containers after use appropriate pumping and switching controls would have to be provided.

U.S. Patent NO. 3,526,203, col. 8, lines 12-19. Although electron microscopy does not reuse solutions, the '203 patent suggests to a skilled artisan the reuse of solutions by pumping them back to their storage containers.

The "Fluid X Changer" (a device used for sustaining slides bearing tissue specimens) also suggests transfer of solutions by pressure. Moreover, the Weiskopf patent discloses a tissue processor which transfers solutions by pressure controls. Thus, the prior art of histological equipment taught the flow of liquids in tissue processing apparatuses from one location to another with vacuum-pressure.

The differences between the prior art and claim 1 of the '460 patent were minor and achievable by simple modification. Moreover, the prior art references collectively suggest *1129 the engineering necessary to achieve these modifications. Simply put, the '203 patent discloses a tissue processor which does not

reuse fluids but instead discharges them into a waste tank after processing. By running a line from the processing chamber back to the fluid storage containers (rather than to the waste tank), the '203 patent would anticipate the '460 patent.

[6] The level of ordinary skill in the art suggests as well a thorough knowledge of the principles of fluid transfer using pressure-vacuum pumps, valves, and conduits at the time of the '460 patent's development. Finally, Miles did not show objective indicia of non-obviousness. Such evidence, if present, would weigh in favor of non-obviousness, although the lack of such evidence does not weigh in favor of obviousness. See, e.g., *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 1 USPQ2d 1196, 1199 (Fed. Cir. 1986). Miles presented no evidence, for instance, that its device represented a substantial share of any definable market. Miles also did not offer evidence on factors such as long-felt need or teaching away in the prior art.

[7] In sum, the district court concluded:

On the basis of the Graham test, therefore, we conclude that claim 1 of the '460 patent is invalid under 35 U.S.C. Section 103 because the subject matter of claim 1 as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains.

Miles I, slip op. at 16-17. This court finds no error (and certainly no clear error) with the district court's obviousness findings and conclusion. Therefore this court affirms the district court's determination of invalidity of claim 1 of the '460 patent.

In its later opinion, the district court clarified its earlier decision and also held dependent claims (2 and 4-7) of the '460 patent invalid. *Miles II*, slip op. at 1-2. Section 282 requires an independent analysis of the validity of each claim. 35 U.S.C. Section 282 (1988); *Ortho Pharmaceutical Corp. v. Smith*, 959 F.2d 936, 942, 22 USPQ2d 119, 1124 (Fed. Cir. 1992). A party challenging the validity of a claim, absent a pretrial agreement or stipulation, must submit evidence supporting a conclusion of invalidity for each contested claim. *Id.* Where the parties stipulate to "representative" claims, however, a validity resolution for the representative claims applies to the other claims as well. See *Panduit Corp. v. Dennison Mfg. Co.*, 836 F.2d 1329, 1330-31, 5 USPQ2d 1266, 1267-68 (Fed. Cir. 1987).

In an April 1988 pretrial "Stipulation of Agreed Fact, Law of the Case and Questions of Law," the parties agreed:

The '460 patent contains seven claims. Claim 1 is the only independent claim. Claims 2 through 7 depend directly or indirectly from claim 1. Consequently, claim 1 is the broadest claim and can be considered to be representative of the claims in this patent.

Miles II, slip op. at 2 n.1. This stipulation of the parties made claim 1 a representative for the other claims in the patent. Thus, the parties, their counsel, and the trial court understood that the result the court reached for claim 1 would bind all other claims. Therefore, this court affirms the district court's invalidation of the dependent claims of the '460 patent.

The district court also determined that the accused device infringed the '460 patent. Because it affirms the district court's invalidity findings, this court need not reach the district court's infringement determination. See *Dana Corp. v. IPC Ltd. Partnership*, 860 F.2d 415, 417, 8 USPQ2d 1692, 1694 (Fed. Cir. 1988), cert.

denied, 490 U.S. 1067 (1989).

CONCLUSION

For the above stated reasons, this court affirms the district court's findings of infringement of the '073 patent and the upholding of its validity. This court also affirms the district court's holding that claims 1, 2, and 4-7 of the '460 patent are invalid due to obviousness.

COSTS

Each party shall bear its own costs for this appeal.

AFFIRMED

FNal U.S. Patent Reissue No. 29,073 issued on December 14, 1976 as a reissue of U.S. Patent No. 3,892,197, which issued on July 1, 1975).

C.A.Fed.

27 U.S.P.Q.2d 1123

END OF DOCUMENT

Appendix 4:

Orthokinetics Inc. v. Safety Travel Chairs Inc., 806 F.2d 1565, 1 U.S.P.Q.2d 1081
(Fed. Cir. 1986).

▽

Orthokinetics Inc.
v.
Safety Travel Chairs Inc.

Court of Appeals, Federal Circuit

Nos. 85-2779 and 85-2812

Decided December 5, 1986

United States Patents Quarterly Headnotes

PATENTS

[1] Patentability/Validity -- Anticipation -- Prior art (§ 115.0703)

Patentability/Validity -- Anticipation -- Publication (§ 115.0705)

Patentability/Validity -- Obviousness -- In general (§ 115.0901)

Federal district court, in granting judgment notwithstanding verdict holding claims for wheelchair invalid as anticipated and obvious, erred by focusing on patent challenger's evidence regarding "on sale/public use" issue, rather than on evidence in support of jury's findings, erred by referring to jury's verdict as "ambiguous," since resolution of ambiguities is province of jury, erred by concluding that claimed invention was disclosed in publication, since claimed "head restraints" were not shown in that reference, and erred by employing inappropriate "would have been able to produce" test of obviousness.

PATENTS

[2] Patentability/Validity -- Construction of claims (§ 115.03)

Federal district court, in granting judgment notwithstanding verdict holding claims for wheelchair invalid for indefiniteness under 35 USC 112, erred by requiring that one claim "describe" invention, since that is role of specification, and by applying "full, clear, concise, and exact" requirement of Section 112 to claim, since such section applies only to disclosure part of specification, and also erred by applying "able to produce" standard in place of statutory "obvious" standard of 35 USC 103.

PATENTS

[3] Infringement -- Contributory infringement (§ 120.13)

Willful infringement is not prerequisite for imposition of personal liability upon corporate officers for their company's direct infringement.

PATENTS

Particular patents -- Wheelchairs

3,815,586, Kazik, Orthopedic Chair With Scoliosis Pads, JNOV holding claims 5 and 6 invalid reversed.

Re. 30,867, Gaffney, Travel Chair, JNOV holding claims 1-5 invalid reversed.

***1081** Appeal from District Court for the Northern District of Ohio, Aldrich, J.

Action by Orthokinetics Inc., against Safety Travel Chairs Inc., Entron Inc., William J. Pivacek, Clark Shipman, and William J. Cole, for patent infringement. From decision granting defendants' motions for JNOV and for new trial, both parties appeal. Reversed and remanded in part and affirmed in part.

Henry C. Fuller, and Fuller House & Hohenfeldt, S.C. both of Milwaukee, Wis. (Daniel J. Sammon, and Watts, Hoffmann, Fisher & Heinke Co., both of Cleveland, Ohio, on the brief) for appellant Orthokinetics Inc.

Charles B. Lyon, and Renner, Otto, Boissellee & Lyon, both of Cleveland, Ohio (Gordon D. Kinder, on the brief) for appellee Safety Travel Chairs Inc., et al.

Before Markey, Chief Judge, Newman, Circuit Judge, and Swygert, Senior Circuit Judge (for the Court of Appeals for the Seventh Circuit, sitting by designation).

Markey, Chief Judge.

Appeal and cross-appeal from a judgment of the United States District Court for the Northern District of Ohio, Civil Action No. C81-130. In Appeal No. 85-2779, Orthokinetics, Inc. (Orthokinetics) appeals from orders: (1) granting a judgment notwithstanding the verdict (JNOV) holding that: (a) claims 5 and 6 of its U.S. Patent No. 3,815,586 ('586 patent) are invalid under 35 U.S.C. § 102(b) and §103; (b) claims 1-5 of its U.S. Patent Re. 30,867 ('867 patent) are invalid under 35 U.S.C. §103 and §112; (c) the defendant officers of defendant corporations are not personally liable for patent infringement and the corporations are free from charges of willful infringement; and (2) conditionally granting a new trial. We reverse and remand with instructions to reinstate the jury verdicts.

In Appeal No. 85-2812, the defendants (collectively,

Safety) appeal from the judgment entered on the verdict on patent infringement and misuse, and denial of a new trial on those issues. We affirm.

*1082 BACKGROUND

I. The Claimed Inventions

Orthokinetics manufactures products for invalids and handicapped individuals, including pediatric wheelchairs. It is the assignee of the '586 patent issued to Raymond A. Kazik (Kazik) on June 11, 1974, entitled "Orthopedic Chair With Scoliosis Pads" and of the '867 patent reissued to Edward J. Gaffney (Gaffney) on February 16, 1982, entitled "Travel Chair".

The '586 patent discloses a wheelchair for treating persons, especially children, afflicted with scoliosis or curvature of the spine. The orthopedic wheelchair has a head restraint and a pair of laterally and vertically adjustable scoliosis pads attached at opposite sides of the chair and so positioned as to provide therapeutic contact with opposite sides of a person seated in the chair. The relevant claims read:

1. In a chair having a seat, a back, and means for supporting the same, the improvement comprising a pair of scoliosis pads each adapted to bear against the sides of a human body, and means for mounting said pads adjacent to opposite side of said chair in such position as to provide therapeutic contact with opposite sides of a person seated in said chair for treatment of curvature of the spine.

2. The improvement defined in claim 1 wherein said mounting means for each pad is vertically adjustable to permit said pads to be positioned in a vertically staggered relationship to develop a therapeutic force couple across said person's trunk tending to straighten out said curvature of the spine.

5. The improvement of claim 2 in combination with a head restraint which coacts with the scoliosis pads to exert therapeutic pressure on the spine.

6. The improvement of claim 5 in which said head restraint comprises pads which embrace the head and means for adjustably positioning said pads with respect to said back.

On January 26, 1981, Orthokinetics sued, alleging infringement of claims 5 and 6 of the nine claims in the

'586 patent. On December 31, 1977, it had disclaimed claims 1 through 4. Because claims 5 and 6 depend from claims 1 and 2, however, they contain all of the limitations of claims 1 and 2.

The '867 reissue patent discloses a collapsible pediatric wheelchair which facilitates the placing of wheelchair-bound persons, particularly children, in and out of an automobile. Orthokinetics asserted infringement of claims 1 through 5 by Safety. Claim 1 reads (underscoring indicates language added by reissue):

1. In a wheel chair having a seat portion, a front leg portion, and a rear wheel assembly, the improvement wherein said front leg portion is so dimensioned as to be insertable through the space between the doorframe of an automobile and one of the seats thereof whereby said front leg is placed in support relation to the automobile and will support the seat portion from the automobile in the course of subsequent movement of the wheel chair into the automobile and the retractor means for assisting the attendant in retracting said rear wheel assembly upwardly independently of any change in the position of the front leg portion with respect to the seat portion while the front leg portion is supported on the automobile and to a position which clears the space beneath the rear end of the chair and permits the chair seat portion retracted rear wheel assembly to be swung over and set upon said automobile seat.

Claim 2 eliminates the language added by reissue in claim 1 and adds:

wherein said wheel chair has a chair frame including back portion extending upwardly from said seat portion and a front leg portion extending downwardly from said seat portion and wherein said rear wheel assembly includes a rear wheel frame that extends forwardly from said rear wheels and wherein said means for retracting said rear wheel assembly includes means pivotally connecting the front of said rear wheel frame to said chair frame, and a retractable strut connecting between said rear wheel assembly and said chair frame to support the wheel chair on the rear wheel assembly and to retract the rear wheel assembly upwardly under the chair seat portion by swinging said rear wheel frame upwardly.

Claim 3 limits the rear wheel frame of claim 2 to one which "comprises an upwardly arched undercarriage

extending between said chair frame and rear wheels." Claim 4 limits the arch of the undercarriage of claim 3 to one which "substantially matches the angle between said seat portion and said front leg portion whereby said undercarriage swings into close proximity to said leg portion and seat portion when said rear wheel assembly is retracted." Claim 5 limits the chair frame of claim 3 to one which "comprises spaced support tubes, said upwardly arched undercarriage fitting between said tubes when the undercarriage is retracted." *1083 All five claims asserted are independent claims.

II. Procedural History

Orthokinetics introduced the Travel Chair to the market in November of 1973. In 1978, Safety Travel Chairs, Inc. (STC) began to sell similar chairs manufactured by Entron, Inc. (Entron). William J. Pivacek, Clark Chipman, and William J. Cole established STC and were the stockholders and officers of STC and Entron. When Orthokinetics sued STC, Entron, Pivacek, Chipman, and Cole, it alleged willful infringement of claims 5 and 6 of the '586 patent and various claims of its then U.S. Patent No. 3,891,229 (229 patent). When the '229 patent reissued as the '867 patent on February 16, 1982, Orthokinetics amended its complaint to allege infringement of claims 1-5 of that patent, and demanded a jury trial. Safety answered that the patents were invalid and not infringed, and counterclaimed that Orthokinetics had misused its patents when it filed its complaint.

On the liability issues only, trial before a six-member jury was commenced on January 4, 1984, and continued until January 16. Unfortunately, the parties and the court did not decide, and apparently did not discuss, in a pretrial conference or otherwise before trial, just what the jury would be asked to do (e.g., return a general verdict, a general verdict accompanied by answers to interrogatories, or a series of special verdicts on individual issues).

At the trial, the district court denied numerous motions for directed verdicts filed by the parties. Under Fed.R.Civ.P. 49 (the parties dispute whether under Rule 49(a) or (b)), the district court submitted to the jury a series of 54 jointly-prepared questions (samples of which are in the attached appendix). The questions recognized the appropriate burdens to be met by each of the parties as well as the corresponding standard of proof with respect to each issue. The jury returned its answers to the questions on anticipation, obviousness, infringement, willful infringement,

misuse, and personal liability of the corporate officers. All were favorable to Orthokinetics.

Viewing the obvious/nonobvious conclusion as one that could be made only by the court, and therefore considering the jury's nonobvious verdict, after it was returned, to have been merely "advisory", the district court entered judgment on January 30, 1984 for Orthokinetics on the infringement and misuse issues only. On February 23, 1984, because it felt validity of the patents had not been decided, the district court denied Orthokinetics' motion for a temporary restraining order and preliminary injunction. On July 17, 1984, on becoming aware of this court's statement that "[t]he obviousness/nonobviousness issue is a legal issue and may be submitted to the jury with proper instructions," *Perkin-Elmer Corp. v. Computervision Corp.*, 732 F.2d 888, 894- 95, 221 USPQ 669, 674 (Fed. Cir.), cert. denied, 469 U.S. 857 (1984), the district court entered judgment on the jury verdicts on patent validity and willful infringement.

Safety filed motions for JNOV on the issues of validity, infringement, and patent misuse, and in the alternative for a new trial.

III. Summary of the District Court's Opinion

On June 14, 1985, the district court filed a 69-page unpublished opinion, vacated its January 30 and July 17, 1984 judgments, and dismissed the complaint and counterclaim. It granted Safety's JNOV motion on validity, holding claims 5 and 6 of the '586 patent invalid because the claimed inventions were: (1) on sale or in public use, under §102(b); and (2) described in a printed publication under §102(b); and (3) obvious under §103. The district court held claims 1-5 of the '867 patent invalid as: (1) indefinite under §112; and (2) drawn to inventions that could have been obvious under §103.

The district court denied and granted portions of Safety's motion for JNOV on infringement. In its denial, it held STC and Entron guilty of infringement. In its grant, it held that (1) Chipman, Cole, and Pivacek had not infringed either of the two patents and were not personally liable for their corporation's infringement; and (2) no defendant had committed acts of willful infringement.

The district court denied Safety's motion for JNOV on patent misuse.

The district court conditionally granted Safety a new

trial if this court were to reverse the district court's entry of JNOV holding the patents invalid. See Fed. R. Civ. P. 50(c)(1), 59(a).

On August 9, 1985, the district court amended its opinion in response to a motion filed by Safety.

ISSUES

(1) Whether the district court erred in granting Safety's motion for JNOV on validity of the '586 and '867 patents.

***1084** (2) Whether the district court erred in denying Safety's motion for JNOV on infringement.

(3) Whether the district court erred in granting Safety's motion on personal liability of corporate officers.

(4) Whether the district court erred in granting Safety's motion for JNOV on willful infringement.

(5) Whether the district court erred in denying Safety's motion for JNOV on patent misuse.

(6) Whether the district court abused its discretion in conditionally granting Safety a new trial.

OPINION

(1) Safety's Motion for JNOV on Validity

A. Introduction

This appeal presents an uncommon and somewhat incongruous situation. The district court entered JNOV on validity in favor of the party who had the burden at trial to prove facts by clear and convincing evidence that would require a conclusion of obviousness. 35 U.S.C. §282; see, e.g., *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1550, 220 USPQ 193, 199-200 (Fed. Cir. 1983); *Moore v. Shultz*, 491 F.2d 294, 298-99, 180 USPQ 548, 551 (10th Cir.), cert. denied, 419 U.S. 930 [183 USPQ 385] (1974). Under the law set by Congress, a jury or a court may reach a conclusion that a patent remains valid solely on the failure of the patent challenger's evidence to convincingly establish the contrary. A patent being presumed valid at birth, § 282, a patentee need submit no evidence in support of a conclusion of validity by a court or a jury. If the patent challenger introduces evidence that might lead to a conclusion of invalidity, a patentee would be well advised to introduce evidence

sufficient to rebut that of the challenger. If the challenger's evidence be totally inadequate, a patentee's motion for judgment or directed judgment that the challenger's §282 burden had not been carried would be appropriately granted before the patentee introduces any rebuttal evidence.

This appeal also illustrates the confusion created in the field of patent litigation by the unwillingness of patentees and alleged infringers to proceed under the rules applicable to all other types of litigation in which a statute or case law has assigned burdens of proof. Courts can hardly be criticized for confusing the burden assignment when counsel proceed as though the statute, § 282, did not exist.

As here, patentees have historically sought to "go first" with testimony on validity, on the empirically unproven premise that a favorable "first impression" of the merits of the invention will carry through to victory. Courts and alleged infringers have acquiesced in the practice. The resulting erroneous but clear impression that patentees bear a burden of "proving validity" has frequently resulted in cluttered records, irrelevant detours, undue burdens on the judicial process, and unnecessary work for the trial court.

Recognizing that trials conducted in accord with the statutorily assigned burdens would not result in assured victory or more victories for either side, courts should consider pretrial orders designed to facilitate such trials.

Similarly, courts should consider pretrial orders in jury trials that specify precisely what the jury will be asked to do after it has been given instructions prepared in light of the evidence and at the end of its deliberations: (1) return a general verdict ("we find for plaintiff/defendant"); (2) return a general verdict accompanied by answers to factual interrogatories prepared in light of the evidence; (3) return special verdicts on specific issues appearing in the evidence ("we find for plaintiff/defendant on the XXXXXXXX issue"; or (4) merely "advise." Unfortunately, as counsel stated at oral argument, that was not done here.

B. Standard of Review

This court has recently reiterated the standard under Fed.R.Civ.P. 50(b) concerning a motion for JNOV in relation to an issue on which the movant did not have the burden of proof:

A trial judge presented with a motion for JNOV (1)

must consider all the evidence in a light most favorable to the nonmover, (2) must not determine credibility of witnesses, and (3) must not substitute his or her choice for the jury's in finding facts, drawing inferences, or deciding between conflicting elements in the evidence.

DMI, Inc. v. Deere & Co., 802 F.2d 421, 425, 231 USPQ 276, 278 (Fed. Cir. 1986); See *Weinar v. Rollform Inc.*, 744 F.2d 797, 805, 223 USPQ 369, 373 (Fed. Cir. 1984), cert. denied, 105 S.Ct. 1844 (1985). If then the district court is "convinced upon the record before the jury that reasonable persons could not reach or could not have reached a verdict for the non-mover, it should grant the motion for directed verdict or for JNOV." *Connell*, 722 F.2d at 1546, 220 USPQ at 197; see *Quaker City Gear Works, Inc. v. Skil Corp.*, 747 F.2d 1446, 1454-55, 223 USPQ 1161, *1085 1166-67 (Fed. Cir. 1984), cert. denied, 105 S. Ct. 2676 (1985).

To convince this court that a trial judge erred in granting a motion for JNOV, an appellant need only show that there was substantial evidence to support the jury's findings and that those findings can support the jury's legal conclusion. *Shatterproof Glass Corp. v. Libbey-Owens Ford Co.*, 758 F.2d 613, 619, 225 USPQ 634, 636 (Fed. Cir.), cert. dismissed, 106 S. Ct. 340 (1985); *Railroad Dynamics, Inc. v. A. Stucki Co.*, 727 F.2d 1506, 1512, 220 USPQ 929, 936 (Fed. Cir.), cert. denied, 469 U.S. 871 (1984). "Substantial evidence is such relevant evidence from the record taken as a whole as might be accepted by a reasonable mind as adequate to support the finding under review." *Perkin-Elmer Corp. v. Computervision Corp.*, 732 F.2d 888, 893, 221 USPQ 669, 673 (Fed. Cir.), cert. denied, 469 U.S. 857 [225 USPQ 792](1984).

Having carefully reviewed the record to determine whether there was such substantial evidence in support of each of the jury's critical findings, we are convinced that the district court inappropriately invaded the province of the jury, in derogation of Orthokinetics' rights as expressed in the Seventh Amendment to the Constitution.

C. The '586 patent

(i) On Sale/Public Use, §102(b)

[1] The jury specifically found (question No. 31) that Safety failed to prove by clear and convincing evidence that the "subject matter" of claims 5 and 6 of the '586 patent was offered for sale or publicly used more than one year before its December 4, 1972 filing date. Because of that finding, the jury had no

reason to, and did not answer the interrogatory on whether Orthokinetics had proved that what Safety alleged was a sale offer/public use was in fact done for an experimental purpose. The district court held that the jury's finding of no offer for sale or public use was "without basis in the record."

It was undisputed that Kazik and Gaffney took a prototype chair Kazik had built to several facilities including the Southern Colony Nursing Home in Wisconsin. On the basis of its view of Orthokinetics' answers to interrogatories and Kazik's trial testimony, the district court concluded that the chair taken to Southern Colony had all the elements of claims 5 and 6. The court stated that the "only testimony to the contrary, certain ambiguous remarks by Gaffney, contradict Orthokinetics' interrogatory answers." The court did not cite the record or otherwise identify the "remarks" referred to.

The district court then determined that the evidence "unmistakably reveals that the purpose of the trips to Southern Colony and other institutions was to commercialize the scoliosis pad chair," (though the jury made no finding on the purpose of the trips) and thus Orthokinetics was "not entitled to the 'experimental use' exception" (on which the jury also made no finding). Because there was insufficient evidence presented concerning the chairs brought to institutions other than Southern Colony, we mention those chairs no further.

The district court focused on evidence in support of Safety's contentions, rather than on evidence in support of the jury's findings. That approach constitutes reversible legal error, particularly where, as here, it involves a virtual disregard of substantial evidence on which the jury could reasonably have reached a contrary determination.

In referring to the evidence in support of the jury's verdict, the district court dismissed it as being "ambiguous". In that characterization, the district court lost sight of the rules, i.e., that resolution of ambiguities (assuming they existed) is a role assigned the jury, and inferences are to be drawn in favor of the nonmovant, Orthokinetics. Thus the court's dismissal of the evidence relied on by the jury as merely "ambiguous" was further legal error.

Orthokinetics points to substantial evidence showing that the Southern Colony chair lacked, among other things, a head restraint coacting with scoliosis pads with vertical adjustability, and that that chair's entire

supporting structure and pad adjusting system was completely changed after the trip to Southern Colony. Alternatively, Orthokinetics challenges the district court's independent determination that it had not established that that chair was taken to Southern Colony for experimental purposes.

Focusing on its own evidence, Safety responds that "neither contention [of Orthokinetics] is supported by the evidence as a whole," thereby indicating a misunderstanding of our appellate role. If we were to determine what the "evidence as a whole" supports, there would be no need for trials or for Rule 50(b). Indeed, Safety's entire argument on appeal reflects its misunderstanding of the rules of Civil and Appellate Procedure governing a jury's role, a district court's role in reviewing motions for JNOV, and this court's role in reviewing that determination. Hence, acceptance of Safety's approach would not only violate established standards of review, but would render a jury impotent.

***1086** Safety concedes that the parties submitted evidence on both sides of each issue. Safety then attacks Orthokinetics' evidence, which is not at issue. As above indicated, Safety bore the burden under 35 U.S.C. §282, and the jury had the right to reject its evidence as insufficient to carry that burden. Under those circumstances, this court may determine only whether the evidence the jury could have believed in making its critical findings was substantial. Because a jury must by definition be permitted to accept some probative evidence and reject other probative evidence, we may not decide whether we would as jurors have found Orthokinetics' evidence, in Safety's words, "believable in light of the evidence as a whole." This is not a case in which there was no evidence in support of a jury's finding, or one in which the only evidence relating to a finding was contrary to that finding. See *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1550, 220 USPQ 193, 200 (Fed. Cir. 1983) ("the jury finding that there was 'no prior art' could not possibly stand in the face of the numerous clearly relevant prior art patents in the trial record").

As too often occurs, the parties here have difficulty restricting themselves to the language of the claims. In distinguishing the Southern Colony chair, for example, Orthokinetics cites a structural feature, "shown" in the patent and a feature that was later modified; yet those features are not found as limitations in the claims.

There is, however, substantial evidence that the Southern Colony chair did not have the claimed elements "a head restraint which coacts with the

scoliosis pads" or a "head restraint which comprises pads which embrace the head." It is clear that the jury could have so concluded on the evidence presented to it. Gaffney testified as to that difference, and the exhibits showing the Southern Colony chair fully support that testimony. Moreover, Kazik did not testify, and Orthokinetics' interrogatory answers did not state, that that chair had a head restraint coacting with the pads. Whether there may or may not have been evidence that might have supported a contrary conclusion is simply irrelevant. Because there was substantial evidence supporting it, the jury's determination that there was no offer for sale or public use of the claimed invention should not have been disturbed. The judgment NOV on the on sale or in public use bar must be vacated and judgement must be entered on the jury's verdict.

Because there was substantial evidence on which a reasonable jury could have found that Safety failed to prove an offer for sale or public use of the claimed invention, we need not discuss the district court's independent determination that Orthokinetics had not established an experimental purpose in the trip to Southern Colony. In light of the instructions given the jury, moreover, it must be concluded that any consideration it gave the question of experimental purpose was resolved by the jury in Orthokinetics' favor. Nonetheless, for the benefit of the parties, we note that Orthokinetics did come forward with evidence of an experimental purpose sufficient to have convinced the jury that even the possibility of a public use bar had been "negated". *TP Laboratories, Inc. v. Professional Positioners, Inc.*, 724 F.2d 965, 971, 220 USPQ 577, 582 (Fed. Cir.), cert. denied, 469 U.S. 826 [224 USPQ 616] (1984); see also *In re Smith*, 714 F.2d 1127, 218 USPQ 976 (Fed. Cir. 1983).

Gaffney testified at trial that the purpose of the trip to Southern Colony was to "test [the chair] with some handicapped children to see if it was ready" and "to see if the chair was ready to be commercialized and if it would do the job we wanted it to do." The jury had the right to construe that testimony as establishing that Orthokinetics was still in an experimental phase when the visit was made to Southern Colony. Whether Kazik's statement that the trip was to see "the scope of the market" might support a contrary conclusion is of no moment in the course of considering a motion for JNOV. The district court's characterization of Kazik's and Gaffney's testimony as "undisputed" is but an indication that the jury was entitled to resolve a conflict, if any existed, between them, and that any inferences to be drawn from that testimony must be

drawn adversely to Safety.

(ii) Printed Publication

The jury found (question No. 26) that Safety failed to prove that the chair claimed in the '586 patent was present in its entirety in Kamenetz, *The Wheelchair Book: Mobility for the Disabled* (1969) (*The Wheelchair Book*). The district court held that *The Wheelchair Book* "clearly discloses" all five elements of claims 5 and 6 of the '586 patent.

Orthokinetics' witnesses testified that the structure disclosed in *The Wheelchair Book* does not include "a head restraint which coacts with the scoliosis pads to exert therapeutic pressure on the spine," as set forth in the claims, particularly because the "head rest" in *The Wheelchair Book* is only a head rest and not a "head restraint" at all. A reasonable jury could clearly have found from that testimony that *The Wheelchair Book* does not anticipate the claimed inventions because it discloses no "head restraint" *1087 and certainly no "head restraint which coacts with the scoliosis pads to exert therapeutic pressure on the spine."

The district court correctly determined that *The Wheelchair Book* shows "headrests, headcushions, headwings and special head supports (including slings, caps, and collars)." That the reference shows those items, however, is simply no basis for finding anticipation. The claims require "head restraints" that are not shown by the reference. The district court was in no position to conclude that headwings embrace the head like a head restraint. Orthokinetics' expert, Professor Cherry, testified that headwings normally "support" the head, but do not "restrain" it. Because anticipation requires the disclosure in a prior art reference of each and every element as set forth in the claim, *Kalman v. Kimberly-Clark Corp.*, 713 F.2d 760, 771, 218 USPQ 781, 789 (Fed. Cir. 1983), cert. denied, 465 U.S. 1026 [224 USPQ 520] (1984), *The Wheelchair Book* cannot anticipate the claimed inventions set forth in claims 5 and 6. See *RCA Corp. v. Applied Digital Data Systems, Inc.*, 730 F.2d 1440, 221 USPQ 385 (Fed. Cir.), cert. dismissed, 468 U.S. 1228 (1984).

There being substantial evidence capable of supporting the jury's finding of no anticipation, and thus a failure of Safety to prove anticipation, the granting of Safety's motion for JNOV on anticipation by *The Wheelchair Book* must be reversed.

(iii) Obviousness

The jury concluded (question Nos. 27-29) that Safety had failed to prove by clear and convincing evidence that the inventions set forth in claims 5 and 6 would have been obvious to persons of ordinary skill in any of a number of arts, including a person "with mechanical skills who has the knowledge of the needs of handicapped children." The district court said that "[t]he jury's answers to [those questions] were without foundation in the evidence."

Again the district court focused on evidence in support of Safety's burden. Noting that Orthokinetics' disclaimer of claims 1-4 was in light of U.S. Patent No. 3,640,571, to Michael Keropian (Keropian), that Keropian disclosed all the elements recited in claims 1-4, and finding that *The Wheelchair Book*, H. Willard & C. Spackman, *Occupational Therapy* (4th ed. 1971), and U.S. Patent No. 3,269,768 to John C. Kinney (Kinney) disclose "head restraints", the district court concluded that it would have been obvious to add the "headrests to the Keropian scoliosis system, or to add the Keropian vertically adjustable torso system to the Kinney head rest and chair mechanism." With those references, the court concluded, "a person of ordinary skill in the art . . . would easily have been able to produce the structure defined by the ['586] patent."

Acceptance of the district court's foregoing analysis would make the conduct of the jury trial a pointless exercise. In accord with its instructions, the jury necessarily concluded that the combining of individual items picked from the references as later done by the district court, would not have produced the claimed inventions or would not have been obvious when the invention was made. No basis or reason exists in the record for the district court to have substituted its contrary conclusion. The jury heard the testimony of Safety's own witness, Professor Cherry, who testified on the improvements contributed in the '586 patent. Those improvements did not consist of a mere combining of a "head rest" with Kinney's scoliosis system; they contributed a coaction between the pads and a head restraint to provide therapeutic pressure at three points. Moreover, that the claims do not contain the phrase "three-point positioning" is not material, the coaction between the pads being effective to produce that result. See *In re Antonie*, 559 F.2d 618, 619, 195 USPQ 6, 8 (CCPA 1978) (claims need not recite inherent advantages relied on for patentability).

Moreover, the district court's analysis employed an inappropriate "would have been able to produce" test. The statute, §103, requires much more, i.e., that it

would have been obvious to produce the claimed invention at the time it was made without the benefit of hindsight.

The jury also found (question Nos. 34-37) that Orthokinetics had proved by a preponderance of the evidence that certain objective indicia support the validity of the '586 patent, i.e., unsuccessful attempts by others, long felt need, and commercial success. Though the district court viewed those jury findings as "without factual foundation," the record reflects substantial evidence on which a reasonable jury could have made each of those findings.

Because the district court erred in setting aside the jury's verdict that the inventions set forth in claims 5 and 6 would not have been obvious, the grant of Safety's motion for JNOV on the validity of the '586 patent must be reversed.

D. The '867 Patent

(i) Indefiniteness

The jury found (question No. 51) that Safety failed to prove by clear and convincing *1088 evidence that the '867 patent was invalid because of claim language that does not particularly point out and distinctly claim the invention. 35 U.S.C. §112, 2dP. The district court determined otherwise and granted Safety's motion for JNOV.

Claim 1, from which the rest of the claims depend, contains the limitation: "wherein said front leg portion is so dimensioned as to be insertable through the space between the doorframe of an automobile and one of the seats thereof."

Noting the testimony of Orthokinetics' expert, Mr. Hobbs, who said the dimensions of the front legs depend upon the automobile the chair is designed to suit, the district court stated:

In response to this testimony, which clearly and convincingly establishes that claim 1 of the ['867] patent does not describe the invention in "full, clear, concise and exact terms," Orthokinetics points only to the conclusory statements of Hobbs, Gaffney and expert witness William McCoy, Jr., that the patent is, in fact definite. These conclusory statements are not an adequate basis for the jury to reject Safety's defense. The undisputed, specific testimony of Gaffney and Hobbs demonstrates that an individual desiring to build a non-infringing

travel chair cannot tell whether that chair violates the ['867] patent until he constructs a model and tests the model on vehicles ranging from a Honda Civic to a Lincoln Continental to a Checker cab. Without those cars, "so dimensioned" is without meaning.

[2] The foregoing statement employs two measures impermissible in law: (1) it requires that claim 1 "describe" the invention, which is the role of the disclosure portion of the specification, not the role of the claims; and (2) it applied the "full, clear, concise, and exact" requirement of the first paragraph of §112 to the claim, when that paragraph applies only to the disclosure portion of the specification, not to the claims. *Standard Oil Co. v. American Cyanamid Co.*, 774 F.2d 448, 453, 227 USPQ 293, 297 (Fed. Cir. 1985). The district court spoke, inappropriately, of indefiniteness of the "patent," and did not review the claim for indefiniteness under the second paragraph of § 112.

A decision on whether a claim is invalid under § 112, Id P, requires a determination of whether those skilled in the art would understand what is claimed when the claim is read in light of the specification. *Seattle Box Co. v. Industrial Crating & Packing Inc.*, 731 F.2d 818, 826, 221 USPQ 568, 574 (Fed. Cir. 1984); *In re Morasi*, 710 F.2d 799, 803, 218 USPQ 289, 292 (Fed. Cir. 1983).

It is undisputed that the claims require that one desiring to build and use a travel chair must measure the space between the selected automobile's doorframe and its seat and then dimension the front legs of the travel chair so they will fit in that particular space in that particular automobile. Orthokinetics' witnesses, who were skilled in the art, testified that such a task is evident from the specification and that one of ordinary skill in the art would easily have been able to determine the appropriate dimensions. The jury had the right to credit that testimony and no reason exists for the district court to have simply discounted that testimony as "conclusory".

The claims were intended to cover the use of the invention with various types of automobiles. That a particular chair on which the claims read may fit within some automobiles and not others is of no moment. The phrase "so dimensioned" is as accurate as the subject matter permits, automobiles being of various sizes. See *Rosemont, Inc. v. Beckman Instruments, Inc.*, 727 F.2d 1540, 1547, 221 USPQ 1, 7 (Fed. Cir. 1984). As long as those of ordinary skill in the art realized that the

dimensions could be easily obtained, § 112, 2d P requires nothing more. The patent law does not require that all possible lengths corresponding to the spaces in hundreds of different automobiles be listed in the patent, let alone that they be listed in the claims.

Compliance with the second paragraph of §112 is generally a question of law. *Shatterproof Glass Corp. v. Libbey Owens Ford Co.*, 758 F.2d 613, 619, 225 USPQ 634, 636 (Fed. Cir.), cert. dismissed, 106 S.Ct. 340 (1985). On the record before us, we observe no failure of compliance with the statute, and thus no basis on § 112 grounds for disturbing the jury's verdict. The district court's grant of Safety's motion for JNOV for claim indefiniteness was in error and must be reversed.

(ii) Obviousness

The jury made numerous findings (question Nos. 39-48) all in support of its conclusion that Safety failed to prove by clear and convincing evidence that the inventions set forth in claims 1-5 of the '867 patent would have been obvious when they were made in view of the prior art to one of ordinary skill in the art.

Having outlined the prosecution history of the '867 reissue patent, the district court stated:

Analysis begins with Gaffney's concession to the [U.S. Patent and Trademark Office] that [U.S. Patent No. 1,693,633 issued to Sarah Allen (Allen)] fully anticipated the original Gaffney patent, rendering *1089 that patent void under § 102. Therefore, the only novel aspects of the reissue patent [i.e. the '867 patent] claims are those portions of such claims which differ from the language of the original patent. Claim 1 added to original Claim 1 a "retractor means for assisting the attendant in retracting said rear wheel assembly . . . while the front leg is supported on the automobile. . . ."

The district court quoted the language added by reissue in claims 2-5 *supra*, and focused on the differences between the reissued '867 claims and those of the original '229 patent. Claims 3-5 were also characterized as adding "minor details."

It is not altogether clear from the passage quoted above whether the district court was comparing the claims of the '867 patent with Allen or with the original patent. A careful reading of the district court's opinion, and its amendments, however, makes clear that the claims of the original patent were applied as prior art

against the '867 patent. That was legal error for the reasons discussed in *Interconnect Planning Corp. v. Feil*, 774 F.2d 1132, 1137, 227 USPQ 543, 546-47 (Fed. Cir. 1985), and Safety's attempt to distinguish that case is unpersuasive.

If the district court compared the '867 claims with the Allen patent, that comparison was based on an erroneous presumption, i.e., that Gaffney made a "concession" that Allen anticipated the claims of the original patent. Gaffney's reissue oath stated only that he believed "the original patent to be wholly or partly inoperative or invalid because claims 1 and 11 are unpatentable over [Allen]." 35 U.S.C. § 251; see 37 C.F.R. § 1.175(1)(1985); *Manual of Patent Examining Procedure* 1414 (5th ed. 1983). That is not, as Safety calls it, a "binding admission" of anticipation. In fact, even a cursory review of the Allen patent shows on its face that the jury could readily have found that it does not disclose each element of Gaffney's original patent.

The district court stated (underscoring indicates amendments adding to the court's original opinion; brackets indicate amendments deleting from the court's original opinion):

Given the jury's findings with respect to the level of ordinary skill in the art, the proper scope and content of the prior art and its details as summarized above, and assuming that the jury's general verdict constitutes a sufficient finding concerning the differences between the prior art and the Gaffney reissue patent claims, the question for this Court is whether any reasonable basis existed for [finding those differences] their finding. On consideration, it is eminently clear that no such basis exists -- that is, that all the differences between claims 1 through 5 of the Gaffney reissue patent [are] and the prior art are such that the claimed invention as a whole would have been obvious in light of the prior art to one of ordinary skill in the art at the time of the Gaffney invention. [Footnotes omitted.]

The district court's amendment changing "the differences are obvious" to "the claimed invention as a whole would have been obvious to one of ordinary skill at the time of the invention" substituted the correct statutory criteria, §103, for the unauthorized "differences are obvious" standard. Despite that change, however, it is clear from the entire record and from a study of the amended opinion in its entirety, that the court substituted its view for that of the jury on the basis of its belief that the presence of individual

elements in separate prior patents required a conclusion of obviousness.

The court concluded that (emphasis added):

clear and convincing evidence demonstrates that in 1972 the holder of a college degree in engineering with experience in the wheel chair fields, presented with the Allen patents and the other patents described above, would doubtless have been able to produce the structure defined in claims 1 through 5 of the Gaffney reissue patent; no probative evidence to the contrary was presented to the jury. The prior art suggests the combination both expressly and by implication, and no original new patent's result is achieved which is not suggested by the combinations. Applying the Railroad Dynamics test, this Court concludes that the jury's implied conclusion that there were differences between the prior art and the claims in issue is unsupported by substantial evidence.

As it did in respect of the '586 patent, the court applied its "able to produce" standard in place of the statutory "obvious" standard of §103. There was probative evidence in support of the jury's conclusion (testimony of Hobbs, Gaffney, Kazik, Inouye, Pivacek). Neither the court nor any witness identified what in the references suggested their combination or what in the references would produce the results of the claimed inventions.

It is unclear whether the district court believed there were no differences between the claimed invention of the '867 patent and the prior art. Though the court listed no differences, it is undisputed that there are at least these differences: the combination of legs as lever for loading the chair into an *1090 automobile and the retraction of the rear wheels by the attendant while the patient remains in the chair. The sole question, therefore, is whether that difference, which we must presume was found by the jury, constituted substantial evidence in support of its nonobvious conclusion.

A review of each of the five prior art references establishes unequivocally that there was substantial evidence in support of the jury's implied findings of those differences. That evidence plus the objective evidence of nonobviousness (commercial success, failure of others, long felt need) supply a fully adequate basis on which a reasonable juror could have concluded that the subject matter as a whole of the inventions claimed in the '867 patent would not have been obvious to one of ordinary skill in the art. Neither

the record nor the district court's opinion provides a basis for the substitution of a conclusion to the contrary. Therefore, the district court's setting aside of the jury's verdict upholding claims 1-5 of the '867 patent must be reversed.

(2) Infringement

The jury found (question Nos. 1-4) that Orthokinetics had met its burden of proving by a preponderance of the evidence that the accused chairs constituted infringement of claims 5 and 6 of the '586 patent. The testimony of Gaffney and Inouye, which supports that finding, faced no cross-examination and went unrebutted by Safety. The district court correctly denied Safety's motion for JNOV on infringement of the '586 patent.

Safety's sole argument on appeal is directed to matter extraneous to claims 5 and 6 of the '586 patent and is clearly without merit.

The jury found (question No. 15) that Orthokinetics had proved by a preponderance of the evidence that the accused chairs constituted infringement of claims 1-5 of the '876 patent. Safety sought JNOV on this issue, arguing that the claims must be limited to a rigid front leg portion extending to the floor, or to a front leg portion having a caster and a caster board fixedly mounted thereon, the leg portion being no wider than 9 1/2 inches at the caster board.

Because Orthokinetics' completely contrary testimonial evidence was fully adequate to support the jury's findings, the district court correctly denied Safety's motion for JNOV on infringement of the '867 patent. For the same reason, Safety's motion for new trial on infringement was properly denied.

(3) Personal Liability for Infringement

The jury found (question Nos. 5-10, 18-23) that Chipman, Cole and Pivacek were personally liable for acts of direct infringement and for inducing infringement of both patents.

The district court held as a matter of law that, because the jury could not have reasonably found the corporate officers liable for willful infringement, it could not find them personally liable for any infringing acts of the corporations. In attempting to support that holding, Safety argues that good faith belief in invalidity, based solely on a dealer's report that a district court had held the original of the '867 patent invalid, precludes a

finding of any personal liability. Because neither proposition has any basis in law, we must reverse the district court's grant of Safety's motion for JNOV on the corporate officers' personal liability.

The jury found the corporate officers liable for direct infringement, 35 U.S.C. §271(a), as well as for inducing infringement, §271(b). The district court's opinion did not treat the finding on inducement, but dealt only with general principles involved in imposition of personal liability for acts of a corporation. However, it is well settled that corporate officers who actively aid and abet their corporation's infringement may be personally liable for inducing infringement under §271(b) regardless of whether the corporation is the alter ego of the corporate officer. *Power Lift, Inc. v. Lang Tools, Inc.*, 774 F.2d 478, 481, 227 USPQ 435, 437 (Fed. Cir. 1985).

[3]Corporate officers are presumably aware of what they are doing, and in that sense they can be said to have acted "willfully." However, that does not mean that their acts must rise to the level recognized by the law as constituting willful infringement as a prerequisite for the imposition of personal liability for the corporation's direct infringement.

To determine whether corporate officers are personally liable for the direct infringement of the corporation under § 271(a) requires invocation of those general principles relating to piercing the corporate veil.

Infringement is a tort, *Carbice Corp. v. American Patents Development Corp.*, 283 U.S. 27, 33, 8 USPQ 211, 213 (1931), and officers of a corporation are personally liable for tortious conduct of the corporation if they personally took part in the commission of the tort or specially directed other officers, agents, or employees of the corporation to commit the tortious act. See generally 3A *1091 W. Fletcher, *Cyclopedia of the Law of Private Corporations* § 1135 (rev. perm. ed. 1975). The cases are legion in which courts have recognized and imposed personal liability on corporate officers for participating in, inducing, and approving acts of patent infringement. See, e.g., *White v. Mar-bel, Inc.*, 509 F.2d 287, 185 USPQ 129 (5th Cir. 1975); *Rex Chainbelt, Inc. v. General Kinematics Corp.*, 363 F.2d 336, 150 USPQ 319 (7th Cir. 1966); see generally D. Chisum, *Patents*, § 16.06, at 16-76 to 16-85 (1986).

The evidence established the makeup and control of STC and Entron. Pivacek testified that he was at all

material times the President and sole stockholder of Entron and that he elected its Board of Directors. He also testified that he is the President of STC and that he, Cole, and Chipman held all of STC's directorships and owned all of the stock in STC. The evidence firmly establishes that Pivacek, Cole and Chipman were directly responsible for the design and production of the infringing chairs and that they were the only ones who stood to benefit from sales of those chairs. That evidence was fully sufficient to support the jury's imposition of personal liability on Pivacek, Cole, and Chipman for the direct infringement of STC and Entron and for STC's contributory infringement. The district court's setting aside of the jury's findings on personal liability must therefore be reversed.

(4) Willful Infringement of the '867 Patent

Fed. R. Civ. P. 50(a) states that a "motion for a directed verdict shall state the specific grounds therefor." Rule 50(b) states that "a party who has moved for a directed verdict may move to have the verdict and any judgment entered thereon set aside and to have judgment entered in accordance with his motion for a direct verdict." A specific reference to an issue in a motion for JNOV cannot preserve that issue for appeal where that issue was not specifically included in a motion for directed verdict made before the jury retired to consider its verdict. See, e.g., *Kinzenbaw v. Deere & Co.*, 741 F.2d 383, 387, 222 USPQ 929, 931 (Fed. Cir. 1984), cert denied, 470 U.S. 1004 (1985).

Faced with its failure to have moved for directed verdict on willful infringement, Safety argues that its motion for directed verdict on infringement encompasses willfulness. That argument is without merit. Infringement and willful infringement are not the same thing, and Rules 50(a) and 50(b) mandate specificity.

Alternatively, however, Safety says Orthokinetics cannot raise on appeal Safety's failure to include willfulness in its motion for directed verdict because Orthokinetics never objected to its inclusion in Safety's motion for JNOV before the district court.

Orthokinetics' reliance here on a page in its brief on the motion is insufficient because that page is not of record before us. Moreover, Orthokinetics' oral statements to the district court indicate that it never intended to contest the inclusion of the issue of willfulness in Safety's JNOV motion. Though the district court might well have refused consideration of

willfulness on the motion for JNOV in light of Rule 50(b), it did not. In view of Orthokinetics' failure to raise an objection before the district court, we will consider the issue. *Cox v. City of Freeman, Missouri*, 321 F.2d 887, 891 (8th Cir. 1963).

The district court determined that, because Safety was told by a dealer of a district court's ruling in another case that the original '229 patent was invalid, (*Palmer v. Orthokinetics, Inc.*, 197 USPQ 207 (C.D. Cal. 1977), rev'd, 611 F.2d 316, 204 USPQ 893 (9th Cir. 1980)), no reasonable and fair minded juror could have found willful infringement, and set aside the jury's findings that STC, Entron, Cole, and Chipman willfully infringed the '867 patent.

A finding of willful infringement is based on a totality of the circumstances. See, e.g., *Kloster Speedsteel AB v. Crucible Inc.*, 793 F.2d 1565, 1579-80, 230 USPQ 81, 90-91 (Fed. Cir. 1986) and cases cited therein. It is not necessary to determine which combination of facts, among those established by substantial evidence at trial and recognized by this court as capable of contributing to a willfulness finding, were relied upon by the jury. This court, and the district court on the motion for JNOV, must uphold the jury determination of willfulness if there is any set of facts supported by substantial evidence and capable of supporting that jury determination. See, e.g., *Shatterproof Glass Corp. v. Libbey-Owens Ford Co.*, 758 F.2d 613, 619, 225 USPQ 634, 636 (Fed. Cir.), cert. dismissed, 106 S.Ct. 340 (1985); *Railroad Dynamics, Inc. v. A. Stucki Co.*, 727 F.2d 1506, 1512, 220 USPQ 929, 936 (Fed. Cir.), cert. denied, 469 U.S. 871 [224 USPQ 520] (1984).

In this case, substantial evidence supports the jury's finding (question No. 24) of willful infringement. The evidence shows that Safety did not consult an attorney until after Orthokinetics initiated this action. The district court's view that Safety could have relied on a dealer's report of a district court ruling in the *Palmer* case that the original *1092 '229 patent was invalid and thus need not have consulted an attorney is insufficient in this case to set aside the jury's finding of willful infringement. Had Safety relied on that prior district court ruling, one might expect that it would have sought counsel when Orthokinetics informed Safety that that ruling had been reversed on appeal. See *Palmer v. Orthokinetics, Inc.*, 611 F.2d 316, 204 USPQ 893 (9th Cir. 1980), rev'd, 197 USPQ 207 (C.D. Cal. 1977). Instead, Safety merely continued to infringe. Moreover, Safety never replied to any of the letters sent by Orthokinetics and declined Orthokinetics' invitation to participate as a protester in

the reissue proceedings.

The jury could properly have viewed the aforementioned evidence as sufficient to establish Safety's complete disregard of Orthokinetics' patent rights. Therefore, the district court's grant of JNOV on willfulness must be reversed.

The corporate officers being personally liable for the acts of the corporations, and the corporations being liable for willful infringement, the jury's finding that Cole and Chipman are willful infringers must be upheld.

(5) Patent Misuse

Because no prior art anticipated the claims of the '586 patent, Safety's assertion that Orthokinetics is guilty of patent misuse for asserting a patent, the '586 patent, that it knew was invalid under §102(b), is without merit.

With respect to the '867 patent, the district court deemed Safety's confused series of assertions, involving the settlement agreement in the *Palmer* case and *Palmer's* customer, unworthy of analysis and insufficient to overcome the jury's finding (question no. 52) which the district court found to have been supported by substantial evidence. We agree.

The district court correctly denied Safety's motion for JNOV on patent misuse and Safety's motion for a new trial on that issue.

(6) Conditional Grant of a New Trial

This court must review a denial or grant of a motion for a new trial under an abuse of discretion standard. *Medtronic, Inc. v. Intermedics, Inc.*, 799 F.2d 734, 740-41, 230 USPQ 641, 645 (Fed. Cir. 1986); *Railroad Dynamics Inc.*, 727 F.2d at 1512, 220 USPQ at 935. "That question turns on whether an error occurred in the conduct of the trial that was so grievous as to have rendered the trial unfair." *DMI, Inc. v. Deere & Co.*, 802 F.2d 421, 427, 231 USPQ 276, 280 (Fed. Cir. 1986); see *Witco Chemical Corp. v. Peachtree Doors, Inc.*, 787 F.2d 1545, 1548, 229 USPQ 188, 190 (Fed. Cir.), cert. dismissed, 107 S.Ct. 258 (1986).

The district court stated that "a new trial is compelled solely by the standards set forth in the Federal Circuit's post-trial *Structural Rubber Products [Co. v. Park Rubber Co.]*, 749 F.2d 707, 223 USPQ 1264 (Fed. Cir. 1984)] case, when read in conjunction with applicable

Sixth Circuit law on Fed. R. Civ. P.49(a)." The district court derived that "Sixth Circuit law" exclusively from "reading liberally," as it said, *Sakamoto v. N.A.B. Trucking Co.*, 717 F.2d 1000, 1006 (6th Cir. 1983).

More specifically, the district court concluded that a new trial would be in order because: (1) the parties "were prejudiced by delivering closing arguments without the benefit of a final -- or even a substantially completed -- version of the special verdict," citing *Sakamoto*; (2) the jury instructions and special verdicts failed to set forth what specific facts had to be found to support a general verdict on validity or infringement, citing *Sakamoto* and *Structural Rubber*; and (3) "substantial injustice ensued from [the court's] efforts to determine the appropriate role of judge and jury at the same time that the Federal Circuit was generating a series of decisions examining the same topic." With respect to reason (3), the district court determined:

Had counsel been aware that factual issues on validity were being submitted to the jury for binding verdicts, they might well have made different submissions, proposals and objections with respect to both the jury instructions and the special verdict. And had this Court been aware that the validity verdict would be binding, it certainly would have taken a different approach to the validity instructions and verdict.

The district court's reasons for a new trial are based on a speculative and overly expansive view of the case law. Moreover, it does not point to any specific flaws in the instructions as given, or what different proposals, objections, and approach would have been taken or justified.

Regarding reason (1), the *Sakamoto* court held that "the disclosure prior to final argument of at least the substance of the Rule 49(a) special verdict interrogatories and supplemental instructions is mandatory." 717 F.2d at 1006 (emphasis added). That court noted "that it may be an abuse of *1093 discretion to fail to show the Rule 49(a) interrogatories to counsel in advance of argument where, because of exceptional circumstances, such as the complexity of the case, unfairness would otherwise result." However, the *Sakamoto* court determined that the appellant had shown to prejudice from the district court's failure to disclose the additional interrogatory before the summation. Nothing that counsel's failure to object or request further argument, and everyone's awareness of the issue represented by the additional interrogatory, established an absence of prejudice, the Sixth Circuit

affirmed the district court's denial of a new trial.

Whether the present case may be categorized as falling within Rule 49(a) or Rule 49(b), *Sakamoto* makes clear that Safety must show actual prejudice, which it failed to do. Safety knew what the issues were from the filing of the pretrial briefs onward and certainly when it assisted with the jointly-prepared jury instructions before closing argument. Moreover, like the appellant in *Sakamoto*, Safety made no objection and no request for further argument.

Regarding reason (2), the district court determined that *Sakamoto* "indicates that a general verdict included together with special verdict questions is impermissible, or at best null." For the reasons set forth above, we do not read *Sakamoto* for that proposition.

The district court said *Structural Rubber* mandates "that a general verdict is valid only if it is the product of instructions which clearly lay out alternative mandatory general verdicts when specific facts are found." In this case, however, there was no objection to the instructions as failing to lay out alternative verdicts based on the evidence adduced.

In *Structural Rubber*, this court remanded for a partial new trial because instructions were given on issues on which no evidence was presented. The alternative mandatory verdict instructions discussed in *Structural Rubber* are desirable and facilitate both jury deliberations and appellate review. This court did not hold in that case that every general verdict is invalid if that particular type instruction was not given. Nor did it hold that a new trial is compelled in such instances when the parties have agreed to the instructions given.

Moreover, in the present case, the jury did not return a general verdict ("we find for the plaintiff"). It returned a series of hybrid special verdicts on each issue with answers to questions on what had and had not been proven.

In all events, non-objecting parties should not be forced to retry the case merely because the instructions and the form of verdict obtained from the jury did not match those involved in any earlier and different case, particularly where the party who failed to convince the jury has shown no prejudice emanating from the instructions given. See *Bio-Rad Laboratories, Inc. v. Nicolet Instrument Corp.*, 739 F.2d 604, 615, 222 USPQ 654, 662 (Fed. Cir. 1984), cert. denied, 469 U.S. 1038 (1984).

Under Fed. R. Civ. P. 51, the failure of Safety to proffer timely, specific objections to the instructions precludes our consideration of any such objection on appeal absent great injustice. *Roberts v. City of Troy*, 773 F.2d 720, 723 (6th Cir. 1985); *Structural Rubber*, 749 F.2d at 714 & n.3, 223 USPQ at 1269 & n.3. Safety's sole timely objection may have been (assuming it was brought to the court's attention before the jury retired, see *Transcontinental Leasing, Inc. v. Michigan National Bank of Detroit*, 738 F.2d 163, 167 (6th Cir. 1984)) to the instruction stating the irrelevancy of the doctrine of prosecution history estoppel when the jury finds literal infringement. The district court correctly determined that instruction to have been proper. See, e.g., *Fromson v. Advance Offset Plate, Inc.*, 720 F.2d 1565, 1571, 219 USPQ 1137, 1141 (Fed. Cir. 1983). There is no merit in Safety's present contention that that instruction misled the jury into not construing the claims in light of the prosecution history, particularly when order instructions told the jury to do precisely that. Instructions must be read in their entirety. See, e.g., *Batesole v. Stratford*, 505 F.2d 804, 809 (6th Cir. 1974); *Grandsky v. Sperry Rand Corp.*, 489 F.2d 502, 503-04 (6th Cir. 1973).

Regarding reason (3), neither Safety nor the district court has indicated how or why the jury might have made different findings or reached different conclusions if Safety or the court had known the jury's verdicts on obviousness would be binding. Nothing of record indicates that either party or the court expected that any jury verdict would be merely "advisory" [FN1] This court had made clear, before] this trial, that jury verdicts in patent cases are binding. See *White v. Jeffrey *1094 Mining Machinery Co.*, 723 F.2d 1553, 1558, 220 USPQ 703, 705 (Fed. Cir. 1983) . cert. denied, 469 U.S. 825 (1984); *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542, 1547, 220 USPQ 193, 197-98 (Fed. Cir. 1983). Having failed to carry its burden before one jury, Safety has shown no such actual prejudice as would warrant a second chance before a second jury and the consequent doubling of the burden on Orthokinetics and the district court.

The case was fully and fairly litigated, the instructions and interrogatories (to which Safety did not object) were jointly prepared and fully adequate to guide the jury in its consideration of the evidence presented. There exists no newly-discovered material evidence. A new trial would therefore be unwarranted. The district court's conditional grant of a new trial was an abuse of discretion and must be vacated.

CONCLUSION

The judgment entered in response to those of Safety's motions for JNOV that were granted is reversed. The judgment entered on the jury verdict in light of the denial of Safety's other motions for JNOV is affirmed. The district court's denial of Safety's motion for a new trial on infringement and misuse is affirmed. The district court's conditional grant of a new trial on validity is vacated.

The case is remanded for entry of judgment on the jury's verdicts, for issuance of an appropriate permanent injunction against infringement by Safety, for an accounting, and for such further proceedings not inconsistent with this opinion as the district court may deem necessary.

AFFIRMED IN PART, VACATED IN PART,
REVERSED IN PART, AND REMANDED

APPENDIX

Question 2

Do you find that Orthokinetics has proved by a preponderance of the evidence that defendant, Safety Travel Chairs, Inc., has directly infringed the following claims of the ['586] patent by sale of Safety TranSporter Chair Models with adjustable scoliosis pads? Please answer: "proved" or "not proved" as to each claim:

Claim 5 "Proved"

Claim 6 "Proved"

Question 5

Do you find that Orthokinetics has proved by a preponderance of the evidence that the defendant, Clarke Chipman, is personally liable for direct infringement of the ['586] patent?

Please answer: "Proved" or "not proved":

"Proved"

Question 24

Do you find that Orthokinetics has proved by a preponderance of the evidence that the infringement of the ['867] patent by any of the following defendants was willful?

Please answer: "proved" or "not proved":

Safety "Proved"

Entron "Proved"

William Cole "Proved"

Clark Chipman "Proved"

Question 31

Have Safety et al. proved by clear and convincing evidence that the ['586] patent is invalid because the subject matter of claims 5 and 6 was publicly used or offered for sale more than one year before the December 4, 1972 filing of the ['586] patent application?

Please answer: "proved" or "not proved":

"Not proved"

Question 40

Do you find that Safety et al. have proved by clear and convincing evidence that the ['867] patent is invalid because the differences, if any, between the prior art and the claimed subject matter, taken as a whole, would not have been obvious to one of ordinary

skill in the art the time the claimed invention was made?

Please answer: "proved" or "not proved" as to each claim of the ['867] patent:

Claim 1 "Not proved"

Claim 2 "Not proved"

Claim 3 "Not proved"

Claim 4 "Not proved"

Claim 5 "Not proved"

FN1 Nor is there any indication in the record that the jury was told that it would be serving in merely an "advisory" capacity. That jurors are unlikely to appreciate the taking of weeks out of their lives, only to have the result of their close attention and deliberations treated as merely "advisory" may account for the extreme rarity of use of advisory juries under Fed. R. Civ. P. 39(c).

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1 U.S.P.Q.2d 1081

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Appendix 5:

In re Carlson, 983 F.2d 1032, 25 U.S.P.Q.2d 1207 (Fed. Cir. 1992)

In re Carlson

Court of Appeals, Federal Circuit

No. 92-1248

Decided December 16, 1992

United States Patents Quarterly Headnotes

PATENTS

[1] Patentability/Validity -- Anticipation -- Prior art (Section 115.0703)

Patentability/Validity -- Obviousness -- Relevant prior art -- In general (Section 115.0903.01)

German "Geschmacksmuster," which is design registration obtained by applicant from German government after performing certain registration procedures, including deposit, qualifies as foreign patent for purposes of 35 USC 102(a), since it is completely "available to the public," even though actually viewing such design in German city may impose burden, since such burden is imposed by law upon hypothetical person of ordinary skill in art who is charged with knowledge of all contents of relevant prior art, and since actual knowledge of Geschmacksmuster is not required, in that hypothetical person is presumed to know all pertinent prior art, whether or not applicant is actually aware of its existence.

PATENTS

[2] Patentability/Validity -- Obviousness -- Relevant prior art -- Particular inventions (Section 115.0903.03)

Patentability/Validity -- Design patents (Section 115.17)

Design for dual compartment bottle is obvious in light of prior art, even though prior art references emphasize asymmetry, whereas claimed design is symmetrical around plane vertically bisecting bottle midway between bottle caps, since, in field of art in which products are deliberately designed as asymmetrical in order to create distinctive, memorable images, it would have been obvious to create "normal," or symmetrical, orientation for design.

PATENTS

Particular patents -- Design -- Bottle

Des. 289,855, Carlson, dual compartment bottle, rejection, in re-examination proceeding, of claim as unpatentable affirmed.

***1208** Appeal from the U.S. Patent and Trademark Office, Board of Patent Appeals and Interferences.

Revlon Inc. and Smiletote Inc. filed request for re-examination of Des. 289,855. From decision of the Board of Patent Appeals and Interferences affirming examiner's rejection of claim as unpatentable, patentee Bradley C. Carlson appeals. Affirmed.

Malcolm L. Moore, of Moore & Hansen (Chad A. Klingbeil, with him on brief), Minneapolis, Minn., for appellant.

Jameson Lee, associate solicitor (Fred E. McKelvey, solicitor, with him on brief; John W. Dewhirst, Richard E. Schafer, Albin F. Drost, and Lee E. Barrett, of counsel), for appellee.

Before Nies, chief judge, and Lourie and Clevenger, circuit judges.

Clevenger, J.

Bradley C. Carlson appeals from the January 9, 1992 decision of the U.S. Patent and Trademark Office (PTO) Board of Patent Appeals and Interferences (Board), Appeal No. 91-2823, affirming the examiner's rejection in reexamination proceeding No. 90/001,935 of the claim of U.S. Design Patent No. 289,855 (Des. 289,855) as unpatentable under 35 U.S.C. Section 103 (1988). We affirm.

I

The two issues raised in this appeal are whether the design protected by a German Geschmacksmuster constitutes an "invention . . . patented . . . in . . . a foreign country" within the meaning of 35 U.S.C. Section 102(a) (1988) and thus may be considered prior art, and whether Des. 289,855 is unpatentable under 35 U.S.C. Section 103 (1988) as obvious in light of the pertinent prior art.

The application that culminated in issuance of Des. 289,855 on May 19, 1987 was filed with the PTO by Carlson on November 19, 1984. The claim of Des. 289,855 covers the ornamental design for a dual compartment bottle as depicted in the six figures included in the design patent.

On April 6, 1990, the PTO granted a request for reexamination of Des. 289, 855 filed by Revlon, Inc.

and Smiletote, Inc., whom Carlson had accused of infringing Des. 289,855. During the reexamination, several references were considered which had not been before the examiner during prosecution of the initial application. The new references were (i) German Geschmacks muster No. 4244, issued to Firma Frankenwald-Presserei Horst Rebhan on May 9, 1984; (ii) U.S. Design Patent No. 86,749, issued to Salvatore Scuito on April 12, 1932, and entitled "Design for a Combined Flask and Drinking Glass Holder" (Scuito); and (iii) a magazine article entitled "News in Packaging," *Drug & Cosmetic Industry* (July 1978) (Redken article), illustrating the type of bottle cap used in Des. 289,855.

A Geschmacks muster is a design registration obtained by an applicant from the German government after performing certain registration procedures. Professor Chisum, in a nutshell, thus describes the registration process in effect in 1984:

[A] person may register an industrial design or model by depositing with a local office an application with a drawing, photograph or sample of the article. Registration is effective on deposit, and lists of registered designs are published a short time after registration.

1 Donald S. Chisum, *Patents* Section 3.06 [2], at 3-107 (1992) (footnote omitted). The local office of deposit of a Geschmacks muster in a *1209 city is the Amtsgericht, which is the local courthouse or seat of government of that city. The published list, which discloses certain particulars of each registration, is contained within the Bundesanzeiger, or Federal Gazette. The information typically disclosed in the Bundesanzeiger, with respect to a registered design, consists of a general description of the deposited design and the class of articles deposited, identifying numbers of the deposited designs, the name and location of the registrant, the date and time of registration, and the term of protection. In addition, the city location of the deposited design is also known because the published list is organized under city headings.

Certified copies of Geschmacks muster are available from the Amtsgericht in which the registered designs are deposited. Such copies typically include the same information regarding the Geschmacks muster as provided in the Bundesanzeiger, *supra*, including the city of deposit, and a copy of the drawing or photograph deposited. In the case of deposited sample articles, certified copies of Geschmacks muster contain

photographs of the sample articles.

The Geschmacks muster in this case embraces three different bottle designs, Nos. 3168-3170. Only Model No. 3168 is pertinent to the design claimed in Des. 289,855. That model is a bottle design consisting of two attached container portions divided by a striking, asymmetrical zig-zag line of demarcation. Each container portion has an externally threaded neck with an associated screw-on cap. As translated, both the Bundesanzeiger publication referring to the Geschmacks muster and the certified copy of the Geschmacks muster state, in relevant part: "An open package with plastic or synthetic bottles with stoppers. . . . Model for plastic products." The description as 'open' signifies that the deposited materials are available for public inspection. In addition, the certified copy of the Geschmacks muster, which was supplied to the examiner as relevant prior art, includes a series of photographs of the three deposited designs taken from various orientations. The Bundesanzeiger identifies the German city of Coburg, Bavaria as the location of the registered design.

Scuito depicts an ornamental design for a combined flask and drinking glass holder. The flask and drinking glass are adjacent to one another and within a smooth-walled holder with a flat, oval base and smooth, plain walls equal in height to the body portions of the flask and glass. Both designs incorporate threaded portions on the receptacles' extremities, presumably to facilitate capping. The overall design disclosed by Scuito, however, is asymmetrical in that the necks of the adjacent receptacles are of different heights.

The final reference in the prior art, the Redken article, illustrates the type of bottle cap used by Carlson in his bottle design, and demonstrates the cap's existence in the art prior to the date of Carlson's invention.

II

Upon reexamination, the examiner rejected Carlson's argument that the Geschmacks muster should not qualify as prior art under section 102(a), and found that the design protected by Des. 289,855 would have been obvious under section 103. Because the Geschmacks muster was issued less than twelve months prior to the date of Carlson's application, 35 U.S.C. Section 102(b) (1988) is inapplicable.

On appeal, the Board cited as its guide and authority *In re Talbott*, 443 F.2d 1397, 170 USPQ 281 (CCPA 1971) (German Geschmacks muster constitutes a

"foreign patent" for purposes of 35 U.S.C. Section 102(d) (1988)), and *In re Monks*, 588 F.2d 308, 200 USPQ 129 (CCPA 1978) (no reason to distinguish between sections 102(a) and 102(d) in determining what constitutes a "foreign patent"). Based on those cases, the Board concluded that a Geschmacksmuster constitutes a patent for purposes of section 102(a). Consequently, the Board held that the Geschmacksmuster was pertinent prior art, and affirmed the examiner's conclusion that Des. 289,855 would have been obvious over the Geschmacksmuster in light of Scuito and the Redken article. Carlson timely appealed the Board's decision to this court.

III

Interpretation of statutory terms is a question of law which this court reviews de novo. *Midwest Plastic Fabricators, Inc. v. Underwriters Labs. Inc.*, 906 F.2d 1568, 1572, 15 USPQ2d 1359, 1362 (Fed. Cir. 1990); *Chaparral Steel Co. v. United States*, 901 F.2d 1097, 1100 (Fed. Cir. 1990).

Assuming no other bar to patentability, a person is entitled to a patent under U.S. law unless the same invention was patented by another person in a foreign country prior to the invention thereof by the U.S. applicant. 35 U.S.C. Section 102(a) (1988). The potential bar thus created by the existence of a patent issued in a foreign country gives rise to the availability of such a foreign patent as a prior art reference for the purpose of determining the validity of the claims in a U.S. patent or pending patent application. See *1210 *Environmental Designs, Ltd. v. Union Oil Co.*, 713 F.2d 693, 695, 218 USPQ 865, 867 (Fed. Cir. 1983), cert. denied, 464 U.S. 1043, 224 USPQ 520 (1984); *In re Zimmer*, 387 F.2d 990, 991, 156 USPQ 252, 253 (CCPA 1968).

A further bar to patentability arises if an applicant for a U.S. patent has been granted a patent in a foreign country on the same invention more than twelve months prior to the date the patent application is filed in the United States. 35 U.S.C. Section 102(d) (1988).

The precise words of section 102 read, in pertinent part:

A person shall be entitled to a patent unless--

(a) the invention was . . . patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or . . .

(d) the invention was first patented . . . by the applicant . . . in a foreign country prior to the date of the application for patent in this country on an application for patent . . . filed more than twelve months before the filing of the application in the United States. . . .

35 U.S.C. Section 102 (1988). With respect to design patents, however, Congress has provided that the time bar in section 102(d) is six months. 35 U.S.C. Section 172 (1988).

In *In re Talbott*, our predecessor court decided, as a matter of first impression, that a design protected by a Geschmacksmuster qualifies under section 102(d) as an invention patented in a foreign country for purposes of applying the statutory time bar against an application for a U.S. design patent covering the same subject matter. 443 F.2d at 1398-99, 170 USPQ at 282. The court rejected the argument that a Geschmacksmuster should not be deemed to fall within section 102(d) because the copyright nature of the rights protected by the Geschmacksmuster is substantially different from the rights inherent in a U.S. design patent. *Id.*, 170 USPQ at 281-82. This rejection was based on reasoning adopted in the case by the Board, which in turn relied upon the opinion of Examiner-in-Chief P.J. Federico in *Ex Parte Weiss*, 159 USPQ 122 (Pat. Off. Bd. App. 1967). With regard to construing "patented . . . in a foreign country" under section 102(d), Federico concluded that the rights and privileges attaching to the protection granted by foreign governments need not be coextensive with the exclusive rights granted under U.S. law, so long as the foreign rights granted are both substantial and exclusive in nature. *Id.* at 123-24. Cf. *In re Howarth*, 654 F.2d 103, 105 n.3, 210 USPQ 689, 690 n.3 (CCPA 1981) ("Not every foreign document labelled a 'patent' is a patent within the meaning of 35 U.S.C. Section 102(a) or (b).") (citing *In re Ekenstam*, 256 F.2d 321, 323, 118 USPQ 349, 351 (CCPA 1958)). Because a Geschmacksmuster conveys substantial and exclusive rights in the design, the Board in *Weiss* held that a Geschmacksmuster qualifies as prior art under section 102(d). 159 USPQ at 124. The court in *Talbott* expressly "adopt [ed] as our own, the reasoning set out so completely in [*Weiss*]." 443 F.2d at 1399, 170 USPQ at 242.

Our predecessor court also had occasion to consider whether the phrase "patented . . . in . . . a foreign country," as used in section 102(a), should have a different meaning from the same language used in section 102(d). The issue arose in *In re Monks*, a case

concerned with the bar to patentability under section 102(d). The Solicitor contended that the date upon which an invention is patented in a foreign country should differ for the purposes of section 102(a) versus section 102(d). At stake was whether the British patent date should be the date the patent finally issued, or an earlier date when the contents of the patent were initially published. 588 F.2d at 309, 200 USPQ at 130 . Emphasizing that section 102(d) relates to foreign patents of the U.S. applicant (of which the U.S. applicant must necessarily be aware), whereas section 102(a) relates to foreign patents of others, the Solicitor argued that the foreign patent date under section 102(d) could properly precede the like date under section 102(a). The court refused to draw such a distinction:

First, there is no basis in the [Patent] Act or its legislative history for making such a distinction. The statute uses the identical phrase, "patented . . . in a foreign country," in each of these sections. Nowhere in the legislative history is there the slightest suggestion that these same phrases be interpreted differently.

Id. at 310, 200 USPQ at 131 . Although this observation was made with respect to the date on which a foreign patent becomes "patented" within the meaning of section 102(d), the language applies equally as well to the present issue of whether a distinction should be drawn between subsections (a) and (d) of section 102 when considering whether a Geschmacksmuster is a foreign patent citable as prior art in a section 103 analysis.

IV

Whether a Geschmacksmuster is a foreign patent under section 102(a) is a question of *1211 first impression. That a Geschmacksmuster qualifies as a patent for section 102(d) purposes is settled law, embraced by the Solicitor, unchallenged by Carlson, and a proposition with which we do not disagree.

Notwithstanding the holding in Talbott and the strong conclusion in Monks that the test for determining what constitutes a foreign patent should not differ between subsections (a) and (d) of section 102, Carlson invites this court to deny Geschmacksmuster the status of patents under section 102(a).

Carlson first points to language in Talbott that recognizes the different situations addressed by subsections (a) and (d) of section 102 and states that the policy considerations underlying the different

subsections, "while overlapping to some extent, are not necessarily identical." 443 F.2d at 1399, 170 USPQ at 282 . Carlson claims to base his argument on this premise.

We do not dispute that section 102(a), relating to potential prior art in the form of patents issued in a foreign country and held by persons other than the U.S. patent applicant, serves a purpose akin to, but different from, section 102(d), which specifies the time within which the owner of a foreign patent must apply for a U.S. patent on the same invention. That distinction, however, does not suggest that a Geschmacksmuster lacks the necessary credentials to qualify as a patent under section 102(a).

Nevertheless, Carlson asserts that the correct interpretation of section 102(a) requires that a foreign patent only serve as prior art if it discloses its invention in a readily-accessible fashion. In essence, Carlson argues that the embodiment of foreign protection must take a form that fully discloses the nature of the protected design in a medium of communication capable of being widely disseminated. Because this requirement is clearly not satisfied by depositing a model in a city courthouse in a foreign land, the embodiment cannot constitute an invention patented in a foreign country for purposes of section 102(a) because it is incapable of providing detailed instruction to a large enough number of persons remote from the location of deposit. Moreover, Carlson argues, since the Bundesanzeiger entry does not explicitly refer to dual-compartment containers, it cannot provide notice of the existence of the pertinent model of the Geschmacksmuster to a designer of such containers.

Carlson correctly surmises that section 102(a) contains a requirement that a foreign patent be disclosed in order to qualify as prior art under section 102(a). The requirement, however, is only that the patent be "available to the public." In re Ekenstam, 256 F.2d 321, 324, 325, 118 USPQ 349, 351 , 353 (CCPA 1958) (citing Brooks v. Norcross, 4 F. Cas. 294, 296 (C.C.D. Mass. 1851) (No. 1,957) (inventions protected by secret/"private" patents do not qualify as "patented abroad" under U.S. law)).

Because the description of the Geschmacksmuster in the Bundesanzeiger does not specifically refer to a multicompartment container, Carlson would have us deem the designs incorporated therein outside of the relevant field of prior art. His argument, however, represents an overly narrow view of the prior art germane to his invention. See, e.g., In re Deminski,

796 F.2d 436, 442, 230 USPQ 313, 315 (Fed. Cir. 1986) (reference must be "within the field of the inventor's endeavor," or if not, "reasonably pertinent to the particular problem with which the inventor was involved." (quoting *In re Wood*, 599 F.2d 1032, 1036, 202 USPQ 171, 174 (CCPA 1979))).

The Bundesanzeiger entry regarding the Geschmacksmuster at issue in this appeal clearly refers to a single package incorporating multiple plastic bottles, thereby alerting the public to potentially relevant designs, and directs the notified reader to proceed to Coburg to obtain the actual design. Once in Coburg, the protected design is completely "available to the public" through the certified copy of the Geschmacksmuster.

We recognize that Geschmacksmuster on display for public view in remote cities in a far-away land may create a burden of discovery for one without the time, desire, or resources to journey there in person or by agent to observe that which was registered and protected under German law. Such a burden, however, is by law imposed upon the hypothetical person of ordinary skill in the art who is charged with knowledge of all the contents of the relevant prior art. *Kimberly-Clark Corp. v. Johnson & Johnson*, 745 F.2d 1437, 1454, 223 USPQ 603, 614 (Fed. Cir. 1984); see also *In re Hall*, 781 F.2d 897, 899-900, 228 USPQ 453, 456 (Fed. Cir. 1986) (doctoral dissertation, catalogued and available at Freiburg University, Germany, provides sufficient "public accessibility" for a printed publication under section 102(b)).

Moreover, actual knowledge of the Geschmacksmuster is not required for the disclosure to be considered prior art. To determine patentability, a hypothetical person is presumed to know all the pertinent prior art, whether or not the applicant is actually aware of its existence. *In re Nilssen*, 851 F.2d 1401, 1403, 7 USPQ2d 1500, 1502 (Fed. Cir. 1988); see also *In re Howarth*, 654 F.2d 103, 106, 210 USPQ 689, 692 (CCPA 1981) ("Section 102 has as one objective that only the first inventor obtain a patent. . . . Foreign 'patents' and foreign 'printed publications' preclude the grant of a patent whether or not the information is commonly known. Under [section] 102 a conclusive presumption of knowledge of such prior art is, in effect, a statutorily required fiction.").

[1] In conclusion, we hold that because the Geschmacksmuster fully discloses the design upon which German law conferred the exclusive rights attendant to the registration, the Geschmacksmuster

qualifies as a foreign *1212 patent for purposes of section 102(a), and therefore constitutes prior art for use in the obviousness analysis under section 103. *In re Zimmer*, 387 F.2d 990, 991, 156 USPQ 252, 253 (CCPA 1968). Cf. *In re Mulder*, 716 F.2d 1542, 1545, 219 USPQ 189, 193 (Fed. Cir. 1983) ("[P]rinted publication . . . is prior art under [section] 102(a), . . . , and thus also 'prior art' under [section] 103.").

V

Whether an invention would have been obvious is a conclusion of law based upon the factual underpinnings stated in *Graham v. John Deere Co.*, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966). Thus, this court reviews an obviousness determination by the Board de novo, while reviewing the factual findings underlying the obviousness determination for clear error. *In re Woodruff*, 919 F.2d 1575, 1577, 16 USPQ2d 1934, 1935 (Fed. Cir. 1990).

Carlson argues that even if the Geschmacksmuster is considered as prior art, Des. 289,855 would nevertheless not have been obvious in light of the Geschmacksmuster, Scuito, and the Redken article. Carlson relies on the fact that the Geschmacksmuster and Scuito, the only references pertinent to the design of a dual compartment bottle, emphasize asymmetry, whereas his dual-compartment bottle design is symmetrical around a plane vertically bisecting the bottle midway between the bottle caps. Citing *In re Cho*, 813 F.2d 378, 1 USPQ2d 1662 (Fed. Cir. 1987), Carlson concludes that since none of the references teach a symmetrical design for a dual compartment bottle, Des. 289,855 must have been nonobvious. We disagree.

In re Cho, concerned with the ornamental design of a bottle cap, contains a succinct statement of when a design patent application should be rejected under section 103:

To support [such] a rejection . . . , the teachings of references must be such as to have suggested the overall appearance of the claimed design. . . . Thus, if the combined teachings suggest only components of the claimed design but not its overall appearance, a rejection under section 103 is inappropriate.

Id. at 382, 1 USPQ2d at 1663-64 (citations omitted). This language describes the situation where each individual element of the design is disclosed in the pertinent prior art, but those elements have not been

combined. In the present case, however, a person of ordinary skill in the art, or stated otherwise, "a designer of ordinary capability who designs articles of the type presented," *id.*, 1 USPQ2d at 1663 (citing *In re Nalbandian*, 661 F.2d 1214, 1216, 211 USPQ 782, 784 (CCPA 1981)), need not necessarily study the prior art in order to understand the potential use of a symmetrical design.

[2] In a field of art such as this, where products are deliberately designed as asymmetrical in order to create distinctive, memorable images, it would have been obvious to one of ordinary skill in the art to create a "normal" or symmetrical orientation for a design. Cf. *In re Wilson*, 345 F.2d 1018, 1020, 145 USPQ 558, 559 (CCPA 1965) (pleasing symmetry is not nonobvious where it represents no more than obvious symmetry with convenience in mind). Indeed, knowledge of symmetry is one reason why more complex designs are developed -- the expected

design configuration is one of symmetry. In any event, Scuito and the Geschmacksmuster manifest "the overall appearance of the claimed design," since it would have been obvious to bury the Geschmacksmuster's line of demarcation between the vessels and create the smooth, uniform surface found in Scuito. The difference in the design of a smooth-walled dual compartment container and one with a visible line of demarcation is not a difference such as would establish the nonobviousness of the design as a whole under *In re Cho*. Because the relevant prior art renders Carlson's design obvious under section 103, the judgment of the Board is **AFFIRMED**.

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25 U.S.P.Q.2d 1207

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Appendix 6:

Chemical Separation Technology Inc. v. United States, 51 Fed. Cl. 771, 63

U.S.P.Q.2d 1114 (Fed. Cl. 2002)

Chemical Separation Technology Inc.

v.

United States

U.S. Court of Federal Claims

No. 97-21C

Decided March 11, 2002

PATENTS

[1] Patent construction -- Claims -- Means (§ 125.1307)

Pursuant to sixth paragraph of 35 U.S.C. § 112, claim that employs means-plus-function language and does not disclose structures, materials, or acts used to perform function are properly construed to refer to corresponding structures described in specification for performing function; in present case, description of preferred embodiment of water treatment apparatus discloses two conduits involved in "influent pipe means" function of delivering water to be treated from water source to reaction vessel, and therefore other conduits, which are used for separate functions, are not implicated in "influent pipe means" limitation.

[2] Patentability/Validity -- Specification -- Claim adequacy (§ 115.1109)

Patent construction -- Claims -- Broad or narrow (§ 125.1303)

Claim language in patent directed to water treatment apparatus that describes claimed "reaction" in terms of introduction of neutralizing agent to waste water, as well as introduction of oxidant and resulting agitation, clearly refers to both neutralization and oxidation subprocesses, and thus is not indefinite, since element at issue describes reaction using language that indicates neutralizing agent is more effectively distributed in water by virtue of oxidation and agitation, since summary of invention states that object of invention is to introduce neutralizing agent and oxidant simultaneously, and description of preferred embodiment discusses injecting neutralizing agent into water "at generally the same point" as oxidant is introduced, and since specification indicates that "simultaneous introduction of the air, water and the chemical" makes reaction more efficient.

[3] Patent construction -- Claims -- Defining terms (§ 125.1305)

Term "removing," as used in patent claim directed to "method of removing metal compounds . . . from waste water," is properly given its ordinary meaning of "to take away" or "eliminate," even though specification

includes example in which treated water had metal ion concentrations below limit permitted by U.S. Environmental Protection Agency, since no special definition of term is apparent in intrinsic evidence, and since limitation from isolated example in specification cannot be read into claim.

[4] Patentability/Validity -- Specification -- Claim adequacy (§ 115.1109)

Claim language in patent directed to method for treating acidic mine waste water, which describes adjustment of pH of water "to from about 5 to about 12," is not indefinite, since use of term "about" does not render claim per se indefinite, since scope of term "about" must be determined based on knowledge of persons skilled in relevant art, and how those persons would approximate 5 or 12 in context of pH scale, and since certain amount of imprecision would be anticipated by those skilled in art; language requiring aeration of water to provide dissolved oxygen concentration "at from about 0.01 lb./hr. to about 70 lbs./hr." refers to rate of aeration rather than rating of aerator, and thus is not indefinite, since intrinsic evidence, viewed as whole, demonstrates that language in question describes aeration rate determined by one skilled in art once other variables, including flow rate of waste water and chemical composition thereof, have been determined.

[5] Patentability/Validity -- Specification -- Claim adequacy (§ 115.1109)

Patent construction -- Claims -- Means (§ 125.1307)

"Neutralizing supply means" limitation, in patent directed to method for treating acidic mine waste water, satisfies particularity requirement of 35 U.S.C. § 112, second paragraph, even though written description does not identify specific structure in diagram referring to "neutralizing supply means," since diagram shows structures, such as feed line, described as connected to claimed means, since specification indicates that apparatus of invention is portable, which suggests that supply means is portable, and since neutralizing substance is caustic, which indicates that supply means is container; therefore, one skilled in art of treating such waste water would understand what was meant by limitation.

[6] Patentability/Validity -- Specification -- Claim adequacy (§ 115.1109)

Patent construction -- Claims -- Defining terms (§ 125.1305)

Term "closely adjacent," referring to proximity of influent pipe end to discharge end of aeration shaft in claim directed to method for treating acidic mine waste water, does not render claim indefinite, since ordinary

meaning of term is clear and not varied by patent, and since one skilled in art would be able to interpret term in context of invention at issue, given that patent clearly sets out key objective of introducing waste water, neutralizer, and oxidant at essentially same point and time in process flow, and since drawing illustrates orientation of influent pipe to aerator.

[7] Patentability/Validity -- Specification -- Claim adequacy (§ 115.1109)

Claim language in patent directed to method for treating acidic mine waste water, indicating that introduction of caustic in treatment causes pH of water to be "substantially instantaneously elevated," is not rendered indefinite by use of word "substantially," since patent does not disclose special meaning for "substantially," and thus term is understood to mean that elevation of pH is nearly instantaneous, and since one of skill in art would know of caustics other than examples in specification that would produce nearly instantaneous elevation of pH.

[8] Patent construction -- Claims -- Broad or narrow (§ 125.1303)

Patent construction -- Claims -- Defining terms (§ 125.1305)

"Aerating the water" step in patented method for removing metal compounds from waste water is properly construed to include introduction of other gaseous oxidants into waste water in addition to air, since preferred embodiment envisions use of other gaseous oxidants, and since this finding is consistent with dictionary definitions of "aeration."

[9] Patentability/Validity -- Specification -- Claim adequacy (§ 115.1109)

Claim language in patent directed to method for removing metal compounds from waste water that requires addition of polymer "in a dilute concentration of from about 0.5% to about 1.5% by weight" is not indefinite, even though claim does not specify whether it refers to dilution of polymer before being added to water or to concentration of polymer in relation to water, since most logical conclusion from claim language itself is that it describes dilution of polymer before it is added to water, and since expert testimony indicated that polymers are traditionally marketed in concentrated form with recommended dilution rate; use of term "about" does not render claim indefinite, since one of skill in art would interpret term to mean "approximately."

[10] Patentability/Validity -- Obviousness -- Relevant prior art -- Particular inventions (§ 115.0903.03)

Patentability/Validity -- Obviousness -- Combining references (§ 115.0905)

Defendant failed to prove, by clear and convincing evidence, that asserted claims in patent directed to

method and apparatus for treating acidic water are invalid for obviousness, since prior art, which employed versions of "batch" treatments, did not envision continuous flow treatment taught by patent, which is major difference from prior art, since there is no evidence of suggestion, teaching, or motivation to combine features of prior art references to derive treatment apparatus described in patent, since claim with limitation that requires placement of influent pipe disposal end closely adjacent to aerator shaft discharge, while similar to prior art teaching, is dependent claim, and claim on which it depends is nonobvious, and since other claims at issue, as construed, are distinct from prior art.

[11] Patentability/Validity -- Anticipation -- Prior sale -- "Sale" (§ 115.0707.03)

Patentability/Validity -- Anticipation -- Prior sale -- Degree of development (§ 115.0707.05)

Defendant proved by clear and convincing evidence that patent claims directed to method for removing metal compounds from waste water are invalid under 35 U.S.C. § 102(b), since plaintiff sold waste water treatment system for use at gold mine more than one year prior to date of application for patent, since that system introduced cationic or anionic polymer to form floccules after neutralization, aeration and agitation of water as required by claims, since evidence shows that system actually operated to remove copper prior to critical date, since features disclosed in patent that were not used at gold mine were enabled by description allowing one skilled in art to practice claims without undue experimentation, since there is no evidence of systematic testing or maintenance of records to indicate that patentee continued to control invention for further development, and since any experimentation that was conducted constituted fine tuning of features not claimed in patent.

[12] Patentability/Validity -- Specification -- Enablement (§ 115.1105)

Patentability/Validity -- Anticipation -- Identity of elements (§ 115.0704)

Patentability/Validity -- Obviousness -- Combining references (§ 115.0905)

Defendant failed to establish that patent claims directed to method for removing metal compounds from waste water are not enabled, that claims are anticipated by prior art, or that claims are obvious in light of prior art, since defendant's nonenabling examples are based on waste streams that are rarely if ever encountered, since cited prior art references do not teach simultaneous neutralization, aeration, and agitation of waste water in same tank as required by claims, and since there is no suggestion or motivation that would lead one skilled in art to modify concepts in

prior art to conform to elements of claims at issue, or to combine references to derive those claims; however, claims embodied in system sold to plant for purpose of removing iron and manganese from dry-ash drainage pond, which are invalid under on-sale bar of 35 U.S.C. § 102(b), are also invalid as obvious, since system in plant is considered prior art.

PATENTS

Particular patents -- Chemical -- Waste water treatment 5,370,800, Stevenson, method for removing metal compounds from waste water, claims 1-7, 10, 18-21, 23-25 invalid as violating on-sale bar; claims 1- 5, 18-21 and 23-25 invalid for obviousness.

4,749,497, Kanzleiter, Simonetti, Ball, and Stevenson, method and apparatus for treatment of acidic water, not invalid.

Action by Chemical Separation Technology Inc. and S.M. Stevenson against the United States, pursuant to 28 U.S.C. § 1498 and takings clause of Fifth Amendment, for recovery of compensation for unauthorized use of two patents. Defendant's motion for partial summary judgment of invalidity was denied (53 USPQ2d 1419). Instant opinion provides rationale for findings following oral ruling on claim construction and trial on invalidity issues.

Louis M. Tarasi Jr. and C. William Kenny, Pittsburgh, Pa., for plaintiffs.

Cameron Elliot; David W. Ogden, assistant attorney general; Vito J. DiPietro, director, Civil Division, U.S. Department of Justice, Washington, D.C., for defendant.

Allegra, J.

Chemical Separation Technology, Inc. (CST) and Sanford M. Stevenson seek compensation from the government, under 28 U.S.C. § 1498(a), for unlawful use of two of their patents. The patents at issue are U.S. Patent No. 5,370,800 (the '800 patent) and U.S. Patent No. 4,749,497 (the '497 patent), both of which relate to the treatment of waste water and are used in a device marketed by CST. In this opinion, the second in this case, the court supplies the rationale for its prior ruling construing the patents and addresses defendant's various assertions that the patents are invalid.

*1117 I. BACKGROUND

CST, an Idaho corporation, and its president and major shareholder, Sanford M. Stevenson, are owners

of two U.S. patents that relate to the treatment of waste water. The '497 patent was applied for on August 7, 1987, as a continuation of abandoned application Ser. No. 820,955, originally filed on January 21, 1986. It was granted on June 7, 1988, and issued to CST by virtue of an assignment from the named inventors (Richard S. Kanzleiter, Thomas G. Simonetti, Kenneth E. Ball, and plaintiff Sanford M. Stevenson) recorded in the U.S. Patent and Trademark Office (PTO) on November 2, 1987. The patent "relates to a method and apparatus for treatment of acidic water and more specifically relates to water treatment of mine drainage." The '497 patent is the preferred embodiment of the primary reaction tank used in the method of the second patent at issue, the '800 patent. The '800 patent was applied for on May 25, 1993, and granted on December 6, 1994. The patented "method" is used in an apparatus constructed by CST known as a "portable interim treatment system" (PIT System or PITS). The PIT System, using a series of chemical agents, precipitates and removes hazardous minerals and compounds from acidic mine waste water. A critical feature of the "method," according to the plaintiffs, is the addition of cationic and anionic polymers [FN 1] to the polluted water, thereby causing the precipitated minerals to clump together (flocculate).

On April 14, 1992, CST made a formal offer of sale of a waste water treatment system utilizing the PIT System to Summitville Consolidated Mining Company (Summitville), a subsidiary of Galactic Resources, Inc. (Galactic). This offer was accepted by Summitville on April 24, 1992, and a purchase order was signed by an agent of Summitville on May 5, 1992. A PIT System was installed at the Summitville site on July 15, 1992. For a short time Galactic utilized the PIT System at the licensed rate, but soon abandoned the site.

The PIT System was left in place at Summitville after Galactic abandoned the site. In December, 1992, defendant, through the U.S. Environmental Protection Agency (EPA), began an emergency Superfund response action at the Summitville site. An outside firm, the Environmental Chemical Company (ECC) was retained to serve as the emergency response contractor to manage the clean-up of the site. The clean-up included treatment of waste water, which ECC accomplished using the PITS already installed at the site. In 1993, ECC issued a request for proposals seeking contract bids for enhancing the capacity of the PIT System. CST submitted a proposal, but ECC chose not to award the contract and performed the work on the PIT System itself.

On January 13, 1997, plaintiffs brought suit claiming that: (i) ECC performed this enhancement, a modification that resulted in an operation of the PIT System at an unlicensed rate; (ii) defendant allowed ECC to perform this work without a license; and (iii) defendant has continued to use plaintiffs' patents without license since 1993. Plaintiffs' complaint seeks compensation for the allegedly unlawful use of their patents pursuant to 28 U.S.C. § 1498 and the takings clause of the Fifth Amendment. On April 28, 1999, defendant responded to the claim of infringement by filing a motion for partial summary judgment, asking this court to declare the '800 patent invalid due to plaintiffs' violation of the on-sale doctrine enunciated in 35 U.S.C. § 102(b). By order dated December 14, 1999, this court found that material questions of fact remained regarding whether the "invention later claimed" was on sale before the critical date. Subsequently, the parties raised issues concerning the construction of the patents in question and defendant raised additional assertions regarding the validity of the '497 and '800 patents. The court conducted a Markman hearing in this case on November 7, 2000, and November 13-14, 2000. On November 14, 2000, the court orally ruled on the issues involving the construction of the patents, reserving for this order an explanation of the reasoning for its various constructs. On November 15-17, 2000, the court conducted trial concerning the factual issues raised in defendant's various assertions that the patents in question were *1118 invalid. Following post-trial briefs, closing arguments in this case were heard on June 29, 2001.

Currently, there are two overarching issues before the court: The first, stemming from this court's oral ruling of November 14, 2000, involves explaining the rationale for this court's construction of the patents in question. The second involves the various assertions defendant has made concerning the validity of the patents. The court will consider these broad issues seriatim.

II. CLAIM CONSTRUCTION

Determination of claim construction, including the terms of art found therein, is a matter of law for the court to decide. *Markman v. Westview Instruments, Inc.*, 52 F.3d 967 [34 USPQ2d 1321] (Fed. Cir. 1995) (en banc), *aff'd*, 517 U.S. 370 [38 USPQ2d 1461] (1996). The Federal Circuit has instructed that, "when construing a claim, a court should look first to the intrinsic evidence, i.e., the claims themselves, the written description portion of the specification, and the prosecution history." *Bell & Howell Document*

Management v. Altek Sys., 132 F.3d 701, 705 [45 USPQ2d 1033] (Fed. Cir. 1997).

"The starting point for any claim construction must be the claims themselves." *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305 [51 USPQ2d 1161] (Fed. Cir. 1999). Generally, a claim is given its ordinary and customary meaning; that is, the meaning given to it by those skilled in the art. *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 [39 USPQ2d 1573] (Fed. Cir. 1996); *Estate of Wicker v. United States*, 43 Fed. Cl. 172, 176 (Fed. Cl. 1999). However, "it is always necessary to review the specification to determine whether the inventor has used any terms in a manner inconsistent with their ordinary meaning." *Northern Telecom, Ltd. v. Samsung Electronics Co., Ltd.*, 215 F.3d 1281, 1293 [55 USPQ2d 1065] (Fed. Cir. 2000) (quoting *Vitronics Corp.*, 90 F.3d at 1582); see also *Zoltek Corp. v. United States*, 48 Fed. Cl. 290, 292 [57 USPQ2d 1257] (Fed. Cl. 2000). [FN 2] Further, "[t]he prosecution history is often helpful in understanding the intended meaning as well as the scope of technical terms, and to establish whether any aspect thereof was restricted for purposes of patentability." *Vivid Technologies, Inc. v. American Science & Engineering, Inc.*, 200 F.3d 795, 804 [53 USPQ2d 1289] (Fed. Cir. 1999); see also *Masco Corp. v. United States*, 47 Fed. Cl. 449, 452 (Fed. Cl. 2000). Summarizing, the Federal Circuit, in its own watershed decision in *Markman*, stated: "To ascertain the meaning of claims, we consider three sources: The claims, the specification, and the prosecution history." *Markman v. Westview Instruments, Inc.*, 52 F.3d at 979; see also *Bell & Howell Document Management v. Altek Systems*, 132 F.3d at 706.

After considering this intrinsic evidence, the court may also "consult trustworthy extrinsic evidence to ensure that the claim construction it is tending to from the patent file is not inconsistent with clearly expressed, plainly apposite, and widely held understandings in the pertinent technical field." *Pitney Bowes*, 182 F.3d at 1309. "Extrinsic evidence consists of all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises." *Markman*, 52 F.3d at 980; see also *Eastman Kodak Co. v. Goodyear Tire & Rubber Co.*, 114 F.3d 1547, 1552 [42 USPQ2d 1737] (Fed. Cir. 1997). However, "[e]xtrinsic evidence may not be relied upon during claim construction when the intrinsic evidence unambiguously defines the disputed claim language." *Personalized Media v. Int'l Trade Comm'n*, 161 F.3d 696, 706 [48 USPQ2d 1880] (Fed. Cir. 1998). Further describing the limited role

such evidence plays, the Federal Circuit has indicated that "[e]xtrinsic evidence is to be used for the court's understanding of the patent, not for the purpose of varying or contradicting the terms of the claims." *Markman*, 52 F.3d at 981 (citing *U.S. Indus. Chems., Inc. v. Carbide & Carbon Chems. Corp.*, 315 U.S. 668, 678 (1942)); see also *Fike Corp. v. United States*, 41 Fed. Cl. 776, 782 (1998).

As noted above, on November 14, 2000, at the conclusion of the *Markman* hearing in the instant case, and before initiation of the trial on the validity issues presented herein, the court orally ruled on all but one of the claim construction issues presented by the parties. While defendant initially raised dozens of issues concerning the construction of the patents,*1119 disputes as to five claims eventually predominated: two regarding the '497 patent and three regarding the '800 patent. The court will discuss the rationale for its prior rulings on these claims first before turning to the construction of the other claims which remain disputed.

A. The '497 patent

Claim 1 of the '497 patent reads:

1.A water treatment apparatus comprising,

a reaction vessel,

a source of acidic or metal-bearing water,

influent pipe means operatively connected to said reaction vessel for delivering said water to be treated from said water source to said reaction vessel,

aerator means having a shaft extending therefrom into said reaction vessel said shaft having a discharge end for discharging oxidant,

said aerator means having an agitation means,

said influent pipe means disposed generally adjacent to the discharge end of said aerator shaft,

a neutralizing agent feed line means leading from neutralizing supply means into said reaction vessel for delivering neutralizing agent,

said neutralization feed line means operatively associated with said aerator shaft such that a discharge end of said neutralizing agent feed line is positioned generally adjacent to said agitation means,

pump means operatively associated with said reaction vessel,

power source means operatively associated with said reaction vessel for energizing said apparatus,

effluent discharge pipe means operatively connected to said reaction vessel for discharging the water, and

automated metering and control means for delivering said neutralizing agent into said reaction vessel through said neutralizing agent feed line means and oxidant from said aerator means at substantially the same time, whereby said oxidant impinging upon the water entering said reaction vessel will aerate said water and establish mixing therein so as to enhance efficiency of distribution of said neutralizing agent in said water to reduce reaction time and enhance efficiency of said reaction.

The parties disagreed as to the construction of two critical aspects of claim 1 of the '497 patent (the two highlighted above). The resolution of those disagreements is as follows:

1. Claim 1: "influent pipe means."

Based solely on its review of the intrinsic evidence, the court concluded that the associated structure for this means-plus-function were influent conduit 9 and conduit 18 in Figure 3 of the patent. While defendant agreed that this element is a means-plus-function, it asserted that the associated structures for this function included not only items 9 and 18 of the patent, but also conduits 21 and 22.

[1] Section 112, paragraph 6 of the Patent Act permits the use of mean- plus-function language:

An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

35 U.S.C. § 112 ¶ 6 (1994). Under this section, the device must perform the identical function as specified in the claims of the patent in suit. *King Instruments Corp. v. Perego*, 65 F.3d 941, 945-46 [36 USPQ2d 1129] (Fed. Cir. 1995), cert. denied, 517 U.S. 1188 (1996). Regarding such means- plus-functions, the Federal Circuit has held that, in the absence of other

claim language that restricts the scope of the claim, the means or steps described exclusively in functional terms are to be construed to cover the corresponding structures described in the specification for performing that function and equivalents thereof. In *Re Donaldson Co.*, 16 F.3d 1189, 1193 [29 USPQ2d 1845] (Fed. Cir. 1994) (en banc); see also *Pfund v. United States*, 40 Fed. Cl. 313, 326 (1998).

Under claim 1, the "inluent pipe means" is designed to "deliver [the metal- bearing] water to be treated from said water source to said reaction vessel." A review of the accompanying Figure *1120 3, reveals that the only two items which perform this function are influent conduit 9 and conduit 18. According to the description of the preferred embodiment, conduit 21 contains aerator shaft 15 and extends down from the aerator motor 6. Contrary to defendant's claim, this item thus is not involved in delivering the water to be treated from the water source to the reaction vessel. The same can be said of conduit 22, which, under the description of the preferred embodiment, does not bring the waste water into the reaction tank, but rather sends a mixture of the waste water, the oxidant and the caustic agent to another area of the reaction vessel, one that may contain internal baffles. Accordingly, the court agrees with plaintiffs that the "inluent pipe means" corresponds only to items 9 and 18 in Figure 3 of the patent.

Image 1 (3.5 X 3.75) Available for Offline Print

2.Claim 1: "whereby said oxidant impinging upon the water entering said reaction vessel will aerate said water and establish mixing therein so as to enhance efficiency of distribution of said neutralizing agent in said water to reduce reaction time and enhance efficiency of said reaction."

In its oral ruling, the court held that this element was definite and that the "reaction" referred to is the introduction of waste water, neutralizer, oxidant and agitation. Defendant argued that this element is indefinite, asserting that the last two elements thereof, beginning with the phrase "enhance efficiency of. . .," are particularly "opaque." It asserted that no "said reaction" is defined in the claim and that it is unclear how the claimed invention "enhances" the "efficiency of distribution of said neutralizing agent."

Regarding whether a patent is sufficiently definite, section 112, paragraph 2 of the Patent Act prescribes:

"The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention." 35 U.S.C. § 112, ¶ 2(1994). Whether a claim is indefinite under this paragraph is a question of law. *Personalized Media Communications, LLC v. Int'l Trade Comm.*, 161 F.3d at 702-03 (citing *North Am. Vaccine, Inc. v. American Cyanamid Co.*, 7 F.3d 1571, 1579 [28 USPQ2d 1333] (Fed. Cir. 1993)). "The test for definiteness is whether one skilled in the art would understand the bounds of the claim when read in light of the specification. If the claims read in light of the specification reasonably apprise those skilled in the art of the scope of the invention, § 112 demands no more." *Miles Labs., Inc. v. Shandon Inc.*, 997 F.2d 870, 875 [27 USPQ2d 1123] (Fed. Cir. 1993) (internal citations omitted), cert. denied, 510 U.S. 1100(1994). Burnishing this explanation, the Federal Circuit, in *Exxon Research and Engineering Co. v. United States*, 265 F.3d 1371 [60 USPQ2d 1272] (Fed. Cir. 2001), recently stated:

In determining whether that standard is met . . . we have not held that a claim is indefinite merely because it poses a difficult issue of claim construction. . . . Under a broad concept of indefiniteness, all but the clearest claim construction issues could be regarded as giving rise to invalidating indefiniteness in the claims at issue. But we have not adopted that approach to the law of indefiniteness; rather, what we have asked is that the claims be amenable to construction, however difficult that task may be. If a claim is insolubly ambiguous, and no narrowing construction can properly be adopted, we have held the claim indefinite. If the meaning of the claim is discernible, even though the task may be formidable and the conclusion may be one over which reasonable persons will disagree, we have held the claim sufficiently clear to avoid invalidity on indefiniteness grounds.

Exxon, 265 F.3d at 1375 (citation omitted). The court further noted that "[b]y finding claims indefinite only if reasonable efforts at claim construction prove futile, we accord respect to *1121 the statutory presumption of patent validity . . . and we protect the inventive contribution of patentees, even when the drafting of their patents has been less than ideal." *Id.* (citations omitted); see also *Athletic Alternatives, Inc. v. Prince Mfg., Inc.*, 73 F.3d 1573, 1581 [37 USPQ2d 1365] (Fed. Cir. 1996).

[2] Applying these root principles, the court finds that one skilled in the art would understand that the "reaction" referred to in this element is the

introduction of waste water, neutralizer, oxidant and agitation. Several pieces of intrinsic evidence support this construction. First, the element under consideration itself describes the reaction as involving the "oxidant impinging upon the water entering said reaction vessel," thereby "establish[ing] mixing therein so as to enhance efficiency of distribution of said neutralizing agent in said water." Further evidence that this, indeed, is the "reaction" referred to in the claim may be found in the summary of the invention, which states that an "object of the invention is to maximize treatment of the water by introducing the neutralizing agent and the oxidant at the same point in the water system simultaneously." Moreover, the description of the preferred embodiment indicates:

The apparatus is connected to a source of the raw water, such as a stream. . . . A caustic substance is injected into the system which neutralizes the acid in the water. At generally the same point, an aerator introduces oxidant into the influent flow stream. The neutralization means and aerator means are in generally close proximity and oriented in generally the same axial position. The flow stream experiences substantially instantaneous elevation of pH and the oxidation rate required for treatment is thereby greatly accelerated.

Finally, emphasizing that the reaction associated with this claim involves both the introduction of the neutralizer and the oxidant, as well as agitation, the specification indicates that where the treatment contains internal baffles, such baffles "allow for mixing, turbulence increasing and extended contact time," and are designed to "insure that the treatment reactions are complete prior to discharge from the reaction vessel." Accordingly, while defendant argues that it is unclear whether the reaction described involves either neutralization or oxidation, the intrinsic evidence associated with the patent leaves no doubt that both subprocesses are involved.

Because, in the court's view, one skilled in the art would understand what was meant by the claim's reference to "said reaction," the court also readily deduces that the patent is not indefinite to the extent it claims a process to "enhance [the] efficiency of distribution of said neutralizing agent." To a certain extent, the meaning of this phrase is bound up with the meaning of the last phrase in this same element, which indicates that the process is designed to "enhance [the] efficiency of said reaction." Regarding this latter point, the patent describes how it more efficiently treats the

waste water, articulating in the specification that:

The simultaneous introduction of the air, water and the chemical in a regulated manner accelerates the reaction time. Because of this instantaneous reaction time, large bulk mixing and reaction chambers are not needed.

To like effect is the summary of the invention, which discloses that "[i]t is a further object of the invention to maximize treatment of the water by introducing the neutralizing agent and the oxidant at the same point into the water system simultaneously." Consistent with this intrinsic evidence, it appears that the apparatus enhances the efficiency of the distribution of the neutralizing agent through aerating and agitating the waste stream at the same time that the neutralizer is being introduced.

Ultimately, defendant relies upon extrinsic evidence--the testimony of its expert--to support its assertion that this element of the claim is indefinite. However, as noted above, it is axiomatic that extrinsic evidence may not be relied upon where intrinsic evidence unambiguously defines disputed claim language. See *Kopykake Enterprises, Inc. v. The Lucks Co.*, 264 F.3d 1377, 1381 [60 USPQ2d 1124] (Fed. Cir. 2001); *Pall Corp. v. Micron Separations, Inc.*, 66 F.3d 1211, 1216 [36 USPQ2d 1225] (Fed. Cir. 1995), cert. denied, 520 U.S. 1115 (1997). As a corollary to this rule, the Federal Circuit has repeatedly proclaimed that extrinsic evidence may not be employed to create ambiguity not found in the patent. See, e.g., *Interactive Gift Exp., Inc. v. Compuserve, Inc.*, 256 F.3d 1323, 1334 [59 USPQ2d 1401] (Fed. Cir. 2001) ("[g]iven the lack of ambiguity in the intrinsic evidence, it would be improper to address any of the parties' arguments relating *1122 to extrinsic evidence"); *Vitronics*, 90 F.3d at 1583 ("In those cases where the public record unambiguously describes the scope of the patented invention, reliance on any extrinsic evidence is improper."). Honoring these tenets, this court rejects defendant's attempt to inject ambiguity into the patent's language through the use of extrinsic evidence. The disputed language is not indefinite.

B. The '800 Patent

Claim 1 of the '800 patent reads:

A method of removing metal compounds selected from iron, manganese, aluminum, zinc, copper, lead, arsenic and chromium from waste water comprising the steps of:

(a) adjusting the pH of the waste water to from about 5 to about 12;

(b) aerating the waste water;

(c) agitating the waste water, where steps (a), (b) and (c) are carried out simultaneously in a reaction tank and waste water is aerated in said reaction tank to provide a dissolved oxygen concentration at from about 0.01 lb./hr. to about 70 lbs./hr. at a waste water input flow rate of from about 50 gal./ min. to about 500 gal./min. for a metals concentration of from about 50 mg./l. to about 1,000 mg./l.;

(d) then adding a flocculating agent polymer selected from a group consisting of cationic and anionic polymers to the water and allowing floccules including said metal compounds to form; and

(e) then separating said floccules including said metal compounds from the water.

1. Claim 1: "Removing."

In its oral ruling, this court construed the phrase "removing" to mean "to take away or eliminate." Defendant noted that the claim recites no particular removal percentage or standard. It argued that, in such circumstances, it is neither reasonable to construe the claim as indicating that the listed metals will be entirely removed nor to construe it as indicating that only a trivial amount of these metals would be removed. Based on references to EPA limits in the patent's specifications, defendant concluded, therefore, that the term "removing" must mean "removing to below the appropriate EPA permitted limit."

[3] Words in a patent are given their ordinary meaning unless it is clear that the patentee intended to use them differently. *National Recovery Technologies v. Magnetic Separation Systems*, 166 F.3d 1190, 1195 [49 USPQ2d 1671] (Fed. Cir. 1999); see also *Gentex Corp. v. Donnelly Corp.*, 69 F.3d 527, 530 [36 USPQ2d 1667] (Fed. Cir. 1995) ("Words in claims are to be given their ordinary meaning in the absence of indication in the patent to the contrary."). In the court's view, "removing" is used in the patent in its ordinary sense-- two accepted dictionary definitions for the word "remove" are "to take away; withdraw" and "to do away with; eliminate." See *The American Heritage Dictionary of the English Language* 1476 (4th ed. 2000). [FN3] While, in limited circumstances, a patentee may "be his own lexicographer," *Vitronics*, 90 F.3d at 1582,

no special definition of the term "removing" is apparent in any of the intrinsic evidence relating to the patent. See *Vivid Technologies, Inc.*, 200 F.3d at 805.

In an effort to force-feed its limiting definition of "removing," defendant focuses on language in an example following the specifications which states that "[w]ater leaving the polishing pond consistently had a metal ion concentration below EPA permitted limits." That this example involved a situation in which the effluent "consistently" had concentrations below EPA limits does not mean, however, that the patented method was to ensure that all effluents would always meet such limits. To the contrary, the Federal Circuit has underscored that, "[w]hile . . . claims are to be interpreted in light of the specification and with a view toward ascertaining the invention, it does not follow that limitations from the specification may be read into the claims" *Sjolund v. Musland*, 847 F.2d 1573, 1581 [6*1123 USPQ2d 2020] (Fed. Cir. 1988). Indeed, in an earlier case, that court similarly cautioned against "limiting the claimed invention to the preferred embodiments or specific examples in the specification." *Texas Instruments, Inc. v. U.S. Int'l Trade Comm'n*, 805 F.2d 1558, 1563 [231 USPQ 833] (Fed. Cir. 1986); see also *Ethicon Endo-Surgery, Inc. v. United States, Surgical Corp.*, 93 F.3d 1572, 1578 [40 USPQ2d 1019] (Fed. Cir. 1996); *Prochroma v. United States*, 46 Fed.Cl. 750, 755 (Fed. Cl. 2000). Based on this precedent, and defendant's failure to produce clear and convincing evidence to the contrary, the court refuses to read a limitation into the claim based upon an isolated example in the specification.

2.Claim 1: "Adjusting the pH of the water to from about 5 to about 12."

In its oral ruling, the court held that this portion of claim 1 is not indefinite and that it refers to "bringing to a pH point within the range specified that optimizes the precipitation of metals, said point to be determined by reasonable experimentation." Defendant had advanced that the use of the term "about" rendered this claim indefinite because it fails adequately to apprise the public of the upper and lower limits of the range-- limits that allegedly are discernible neither from the specification, prosecution history, nor prior art. Defendant charged that the patent does not give an indication how far below a pH of 5 or above a pH of 12 a user may go without infringing. In response, plaintiffs argued that the range specified is as precise as the art allows.

Defendant relies heavily on snippets plucked from *Amgen, Inc. v. Chugai Pharmaceutical Co., Ltd.*, 927 F.2d 1200 [18 USPQ2d 1016] (Fed. Cir. 1991), cert. denied, 502 U.S. 856 (1991), a case that involved a patent for DNA sequences. There, the Federal Circuit affirmed the district court's ruling that the term "at least about 160,000" international units per absorption unit (IU/AU) was indefinite. Adopting the district court's reasoning, the Federal Circuit held the claims invalid because the term "about" failed to advise one skilled in the art of the "mean value" between the prior art value of 128,620 IU/AU and the "mean specific activity level of 160,000" that would constitute infringement. *Id.* at 1218. Critically, the court noted that the "at least about 160,000" language was added after the examiner rejected "at least 120,000," which the examiner found was anticipated by the prior art. *Id.* at 1218. However, the Federal Circuit stated that, given this prosecution history, the claims would also be invalid without the limitation of "about" and cautioned that its ruling "should not be understood as ruling out any and all uses of this term in patent claims." *Id.* at 1218.

[4] Thus, contrary to defendant's intimations, Amgen expressly rejects the sweeping proposition that use of the term "about" renders a claim per se indefinite. As further evidence of this, various cases have held claims employing this language to be definite. [FN 4] They teach that the "determination of the 'technological scope' that should be given to the term 'about' is dependent on the context of the use of the term and the precision or significance of the measurements used." *Zoltek Corp.*, 48 Fed.Cl. at 300; see also *Eiselstein v. Frank*, 52 F.3d 1035, 1040 [34 USPQ2d 1467] (Fed. Cir. 1995) ("[t]he meaning of the word 'about' is dependent on the facts of a case, the nature of the invention, and the knowledge imparted by the totality of the earlier disclosure to those skilled in the art"); *Modine Mfg. Co.*, 75 F.3d at 1554. As noted in a leading treatise:

The use of the term 'about' permits some leeway in the amount of a required constituent in a claim. Such broadening usages as 'about' must be given reasonable scope; they must be viewed by the decision maker as they would be understood by persons experienced in *1124 the field of the invention. Although it is rarely feasible to attach a precise limit to 'about,' the usage can usually be understood in light of the technology embodied in the invention.

Robert L. Harmon, *Patents and the Federal Circuit* § 5.6(b) at p. 251 (5th ed. 2001) (hereinafter *Harmon*). As such, the term "about" must be given a reasonable

scope and be viewed by this court as it would be understood by persons skilled in the field of the invention. *Modine*, 75 F.3d at 1554 (citing *Andrew Corp. v. Gabriel Electronics, Inc.*, 847 F.2d 819, 821-22 [6 USPQ2d 2010] (Fed. Cir. 1988)).

Unlike the case in *Amgen*, the pH range specified in the '497 patent was not designed to distinguish this patent from prior art. As such, in the context of this patent, questions such as whether a pH of 4.5 is "about 5" focus solely on what an individual skilled in the art would consider an approximate of 5 in the context of the pH scale, and, more broadly, a waste water treatment method). [FN5] And what one skilled in the art would consider to be "about 5" in the context of that scale, in which each increasing number represents an order of magnitude, might vary considerably from what that same individual would view as being "about 5" on a scientific scale in which the units of measurement were different (e.g., the Moh scale or the Richter scale). That there inevitably is this variation from scale to scale, however, does not render the claim here indefinite, as illustrated by the fact that the Federal Circuit has, on several occasions, construed the scope of a range of "about" numbers in determining whether a patent was infringed. See, e.g., *Conopco Inc. v. May Dep't Stores Co.*, 46 F.3d 1556, 1561 [32 USPQ2d 1225] (Fed. Cir. 1994), cert. denied, 514 U.S. 1078 (1995). Indeed, given that this patent prescribes a method for dealing with a wide range of contaminated waste water streams, some imprecision in the actual range of pH necessary to precipitate out the contaminants seemingly would be anticipated by one skilled in the art-- a point ultimately confirmed by expert testimony in this case. [FN6]

3.Claim 1: "aerated in said reaction tank to provide a dissolved oxygen concentration at from about 0.01 lb./hr. to about 70 lbs./hr."

This court ruled that this language, considered in conjunction with that portion of the claim that recites gallonage and milligram ranges, refers to a rate of aeration and that the ranges so specified were not intended as limitations on the patent. This court thereby rejected defendant's assertion that this language was indefinite.

To be sure, the disputed language is not a picture of clarity. It might be viewed as referring to a particular oxygen concentration or as indicating that the aerator should possess a particular rating--references in the specifications, indeed, suggest both interpretations.

But, the interpretation that makes the most sense, and which is most consistent with the intrinsic evidence, as a whole, is that the language refers to a rate of aeration. Thus, the detailed description of the patent indicates that "[t]he rate of aeration would normally be from about 0.01 lbs./hr. to about 70 lbs./hr. for a metals concentration of 50 mg./l. to 1,000 mg./l. at a raw water input flow rate of 50 gal./min. to 500 gal./min." This language in the specification tracks the prosecution history, which reveals that the claim language was an amendment to the patent. By way of explaining this amendment, the wrapper includes a letter from the applicant's attorney, which states:

The applicant wishes to make of record that the undersigned attorney and the Examiner agreed during their telephone interview that the purpose of aeration and flow rate limitations added by the amendment to step (c) of claim 1 was to define a range of dissolved oxygen concentration for the metals concentration which would result from [sic] the recited ratios of aeration and flow rate limitations. The intention of this language was not to limit the application of this claim to *1125 any particular waste water flow rate such as 50 gal./min. to 500 gal./min.

Support for this interpretation is also found in the extrinsic evidence received by the court. Both plaintiffs' expert, Dr. Roth, as well as defendant's expert, Mr. Dupon, testified that if one skilled in the art knew the water input flow rate and the nature and extent of the metals concentration, he or she could adjust the rate of aeration to generate an optimum dissolved oxygen concentration--one that would maximize the efficiency of the reaction. Dr. Roth further indicated that "one skilled in the art would conclude that the range relates to the rate of aeration, that will supply the needed oxygen concentration to effect an appropriate reaction based upon the influent

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flow rate," noting further that "[o]ne skilled in the art . . . could easily calculate the equivalent oxygen concentration based upon the rate of aeration." For his part, Mr. Dupon rejected the idea that the referenced language referred to a particular dissolved oxygen concentration or a particular aerator rating. Instead, he candidly agreed that the most likely interpretation of the language was as a reference to a rate of aeration--one that would lead to the proper oxidation of the waste stream. Mr. Dupon, however, discounted this interpretation based on his view that one skilled in the art would recognize that some waste water metal contaminants might not need to be aerated at all to be precipitated. In his testimony at the Markman hearing, however, he never suggested that the presence of some minimal amount of oxygen, e.g., that obtained at an oxidation rate of 0.01 lbs per hour, would prevent the precipitation of such contaminants. Consequently, on the whole, even Mr. Dupon grudgingly agreed that the most likely interpretation of the language in question was that it referred to a rate of aeration.

Overall, the court believes that the intrinsic evidence is adequate to demonstrate that the language in question refers to a rate of aeration to be determined by one skilled in the art once other variables, including the rate of flow of the waste water and the chemical composition thereof, were determined. And though not determinative, it is noteworthy that that intrinsic evidence is also supported by expert testimony.

C. Other Claims Construed

1. '497 Patent

At the outset, it should be noted that plaintiffs and defendant agreed as to the construction of various claims in the '497 patent. Based upon those agreements, the court construed the relevant claims, as follows:

Claim 1: "means" elements##means-plus-function elements and limited to the corresponding structure described in the specification and equivalents thereof

Claim 1: "aerator means having a shaft extending therefrom into said reaction vessel said shaft having a discharge end for discharging oxidant, said aerator means having agitation means."##means-plus-function elements, construed together, corresponding to motor 6, shaft 15, aerator prop 16 and

discharge tip 17 in Figure 3, with aerator prop 16 providing agitation

Claim 1: "a neutralizing agent feed line means. . . for delivering neutralizing agent"##means-plus-function element, describing the function of delivering the neutralizing agent and corresponding to caustic feed line 19

Claim 1: "pump means operatively associated with said reaction vessel"##means-plus-function element, describing the function of pumping the caustic and corresponding to metering pump 12

Claim 1: "power source means operatively associated with said reaction vessel for energizing said apparatus"##means-plus-function element, describing the function of energizing the apparatus and corresponding to a portable generator or line power

Claim 1: "effluent discharge pipe means operatively connected to said reaction vessel for discharging the water"##means-plus: function element, describing the function of discharging the water and corresponding to effluent conduit 11

Claim 3: "means for receiving precipitants from said mixture"##includes a thickener, a clarifier, and a settling pond

Claim 3: other "means elements"##Definite

Claim 3: "generally adjacent" and "generally the same point"##Definite

Claim 5: "substantially simultaneous"##Definite

Regarding the construction of other claims in the '497 patent on which the parties disagreed, the court's rationale for its prior oral ruling is, as follows:

(i)Claim 1: "neutralizing supply means."

The court ruled that this phrase is not indefinite and that the structure associated therewith is "a container containing a caustic, usually liquid, that is exterior to the tank, is portable and readily moveable, and is connected to the caustic feedline 19." In arguing that this element of the claim was indefinite, defendant noted that the drawings do not indicate the "caustic supply means" and reasoned that "no person skilled in the art can discern whether the 'neutralizing supply means' is a tank of caustic, a caustic generating machine, or something else." Adverting to Atmel Corp.

v. Information Storage Devices, Inc., 198 F.3d 1374 (Fed. Cir. 1999), defendant contended that absent the disclosure of a structure, it is impossible for a person with ordinary skill in the art to understand the breadth of the disputed language, thereby making claim 1 indefinite.

To be sure, in Atmel, supra, the Federal Circuit emphasized the importance of having a means-plus-function associated with a structure. Atmel, 198 F.3d at 1380. The court, however, did not hold that the structure had to be depicted in a figure accompanying the specification. Rather, in commenting on the particularity requirement, it noted, with approval, the portion of the Patent and Trademark Office's Supplemental Examiner Guidelines which indicates:

The written description does not have to explicitly describe the structure (or material or acts) corresponding to a means (or step-) plus- function limitation to particularly point out and distinctly claim the invention as required by 35 U.S.C. 112 ¶ 2. Rather, disclosure of structure corresponding to a means-plus-function limitation may be implicit in the written description if it would have been clear to those skilled in the art what structure must perform the function recited in the means-plus-function limitation.

Atmel, 198 F.3d at 1380 (quoting PTO Supplemental Examiner Guidelines on Applying 35 U.S.C. § 112 ¶ 6, 58 Fed.Reg. 443, 444 & nn. 12 & 13 (1999)). Guided by these standards and its prior decision in *In re Dossel*, 115 F.3d 942, 946-47 [42 USPQ2d 1881] (Fed. Cir. 1997), the Atmel court emphasized that the essence of the structure requirement is that "the corresponding structure(s) of a means-plus-function limitation must be disclosed in the written description in such a manner that one skilled in the art will know and understand what *1127 structure corresponds to the means limitation." Atmel, 198 F.3d at 1382; see also *S3 Inc. v. Nvidia Corp.*, 259 F.3d 1364, 1367 [59 USPQ2d 1745] (Fed. Cir. 2001).

[5] Thus, in order for a means-plus-function limitation to meet the particularity requirement of § 112 ¶ 2, the written description need not identify a particular structure in a figure that is associated with the claim, provided adequate disclosure for one skilled in the art is otherwise made. Bringing this standard closer to home, the court finds that the patentees here adequately disclosed sufficient structure in the specification to give meaning to the phrase "neutralizing supply means." Thus, the specification indicates that the "caustic feed line 19 connects caustic supply means (not shown) to the reaction vessel 4." It also notes repeatedly that the "apparatus of the invention" is "portable," thereby suggesting that the "neutralizing supply means" must also be portable. [FN7] Further, the specification discloses that the neutralizing substance is a caustic (e.g., "[a] caustic substance is injected into the system which neutralizes the acid in the water"), which defendants admits one skilled in the art would know would usually be a liquid, [FN8] Finally, it is evident that if the neutralizing supply is either a liquid, or even a gas, it must be in some sort of a container. Combining all of these elements together led the court to conclude that one skilled in the art would know that the structure needed to perform the function recited in this means-plus-function is "a container containing a caustic, usually liquid, that is

exterior to the tank, is portable and readily moveable, and is connected to the caustic feedline 19." Accordingly, despite the fact that this structure is not shown in the figures in the patent, the court finds that the phrase "neutralizing supply means" meets the particularity requirement in section 112, paragraph (6) and, therefore, is definite.

(ii) Claim 1: "automated metering and control means."

The court likewise ruled that this element is not indefinite and refers to the metering pump 12 and control panel 13 in the accompanying Figure 2 of the patent. Defendant argued that this means clause is indefinite.

This means clause has two functions--"delivering said neutralizing agent into said reaction vessel through the neutralizing agent feed line means" and delivering "oxidant from said aerator means at substantially the same time." Defendant admitted that the first of these functions is performed by metering pump 12, but asserted that no structure was disclosed which might perform the second of these functions, that is, delivering the oxidant from the aerator at substantially the same time. Regarding the structures associated with this means clause, the patent's description of the preferred embodiment provides:

FIG. 2 shows metering pump 12, which is used to control the amount of fluid introduced into the system. Control panel 13 is used to monitor flow of fluids into the system. . . . The metering pump through a pH monitoring device maintains a proper pH level for the effluent.

Image 2 (4.5 X 3.75) Available for Offline Print

From this description, it is evident that the "automated metering and control means" also includes control panel 13.

At first blush, the role played by the control panel 13 in monitoring the delivery of the oxidant from the aerator is somewhat obscure. The description of the control panel quoted above anticipates that panel would monitor the "flow of fluids," and other claims in the patent, as well as the specification, teach that many of the oxidants anticipated to be used in the processes are gases, such as air. However, Dr. Roth, clarified that one skilled in the art would know that the phrase "fluids" refers not only to liquids, but also to gases. And, his view is in accord with the common definition of the term "fluid," which encompasses both liquids

and gases. See The American Heritage Dictionary of the English Language 677 (4th ed. 2000) ("A continuous, amorphous substance whose molecules move freely past one another and that has the tendency to assume the shape of its container; a liquid or gas"); see also *In Re Smythe*, 480 F.2d 1376, 1383 [178 USPQ 279] (C.C.P.A. 1973) (fluid includes both gas and liquid). Accordingly, contrary to defendant's claims, the patent does reveal control structures that perform the function of delivering the oxidant from the aerator means, to wit, the metering pump 12 and control panel 13.

(iii) Claim 2: "The apparatus of Claim 1 wherein said influent pipe is disposed closely adjacent to the discharge end of said aeration shaft whereby the relative general proximity of said water source means said neutralizing agent feedline discharge end and said agitation means will enhance the efficiency of the reaction."

In its oral ruling, this court held that this claim is definite and was depicted in Figure 3 of the patent. Defendant had argued that the phrase "closely adjacent" lacked any defined meaning and, therefore, was indefinite. It asserted that while Figure 3 of the patent provided a preferred embodiment-- an example of how one might achieve general adjacency--it did not cure the indefiniteness problem because the parameters of such adjacency still were undefined.

[6] In the courts' view, the phrase "closely adjacent" has an ordinary, accepted meaning that is not varied by the patent. The dictionary defines the term "adjacent" as "close to; lying near" or "next to; adjoining," and defines the adjective "close," the root for the adverb "closely," as "being near in relationship" and "having little or no space between elements or parts." See The American Heritage Dictionary of the English Language 21, 349 (4th ed. 2000). These words, taken in combination, thus suggest that the influent pipe has an endpoint not distant from the discharge end of the aerator shaft. To be sure, this terminology does not require a particular orientation (e.g., a 45<<degrees>> angle), nor a specific distance between the endpoint (e.g., 6 inches). Yet, in the court's view, one skilled in the art would know what was meant by this language. [FN9] This is particularly so as other language in the patent emphasizes that a key object of the patent is to introduce the water, the neutralizer and the oxidant at essentially the same point and time in the process

*1129 flow. Thus, in the description of the preferred embodiment, the patent indicates that "[t]he neutralization means and the aeration means are in generally close proximity and oriented in generally the same axial position." Finally, it bears noting that the orientation of the influent pipe to the aerator depicted in figure 3 provides further support for this court's construction of the "closely adjacent" language. [FN10]

(iv) Claim 3: "means for introducing a source of acidic or metal-bearing water into a treatment unit."

This court ruled that this element of claim 3 is definite and is a means-plus-function associated with influent conduit 9, conduit 18 and conduit 22 in Figure 3 of the patent. Defendant had argued that the structure associated with this function could not be the "influent pipe means" (i.e., structures 9 and 18) because that structure is already claimed and performs the same function.

In the court's view, however, there is nothing inconsistent with some of the structures associated with the "influent pipe means" also serving as a "means for introducing a source of acidic or metal-bearing water into a treatment unit." To be sure, as defendant points out, the doctrine of claim differentiation states that different claims should be presumed to have different scope, which "means that an interpretation of a claim should be avoided if it would make the claim read like another one." *Autogiro Co. of Am. v. United States*, 384 F.2d 391, 404 [155 USPQ 697] (Ct. Cl. 1967). However, claim differentiation is not a "hard and fast rule of construction," *Kraft Foods, Inc. v. Int'l Trading Co.*, 203 F.3d 1362, 1368 [53 USPQ2d 1814] (Fed. Cir. 2000) (citations and quotation marks omitted), and does not inflexibly command a particular interpretation. See also *Bristol-Myers Squibb Co. v. Ben Venue Laboratories, Inc.*, 246 F.3d 1368, 1376 [58 USPQ2d 1508] (Fed. Cir. 2001). Common sense, not entirely out of place even in this complex legal context, suggests that in some instances a single structure can perform multiple functions--a pipe, for example, can serve both to transfer liquid from one point to another while also separating that liquid from other material during transit. Bearing out this intuition, both the Federal Circuit and this court have concluded that, providing no ambiguity is introduced, the same structure may perform more than one task and thus correspond to two or more differently-worded means-plus functions. See *Davies v. United States*, 31 Fed.Cl. 769, 775-76 [35 USPQ2d 1027] (1994) (finding two

means-plus function claims associated with a single disclosed structure); see also *Ballard Medical Products*, 268 F.3d at 1361; *Caterpillar Inc. v. Deere & Co.*, 224 F.3d 1374, 1377 [56 USPQ2d 1305] (Fed Cir. 2000).

But even if the doctrine of claim differentiation were otherwise, there is not a complete identity between the "influent pipe means" and the "means for introducing a source of acidic or metal-bearing water into a treatment unit." Rather, the former is subsumed within the latter. Thus, while items 9 and 18 serve as the corresponding structures for both portions of claim 1 and the means-plus-function in claim 3, the latter function also appears to be associated with item 22 of Figure 3, which, according to the specification, is the "conduit" which "sends the mixture to an area of the tank that may contain internal baffles." That the latter area of the tank is also part of the treatment unit is made clear in Figure 1 of the patent, which, in combination with the description of the preferred embodiment, indicates that the entire tank constitutes the "treatment unit."

(v) Claim 9: "wherein the pH is

In its oral ruling, this court construed this phrase to mean "a level of pH elevation caused by introduction of a caustic, e.g., sodium hydroxide, potassium hydroxide, magnesium hydroxide, barium hydroxide, and combinations *1130 thereof." Defendant asserts that this phrase, in essence, means that the claim requires a neutralizing agent that would act the quickest and cause the pH to rise the fastest. Although defendant does not assert that this claim, if interpreted in this fashion, is indefinite, it does suggest that if the claim is not so interpreted, the use of the term "substantially" would render the claim indefinite.

[7] Defendant's argument, however, rests on the mistaken premise that the use of the word "substantially" inevitably introduces fatal ambiguity into a claim. Not so. Rather, words of degree are entirely appropriate "when serving reasonably to describe the claimed subject matter to those of skill in the field of invention, and to distinguish the claimed subject matter from the prior art." *Andrew Corp.*, 847 F.2d at 821. And this court has held that words of degree may be used "to prevent the avoidance of infringement by minor changes that do not affect the results sought and accomplished." *C.E. Equipment Co., Inc. v. United States*, 17 Cl.Ct. 293, 299 [13 USPQ2d 1363] (1989); see also *Knorr-CLAIM## CONSTRUCTION*

Bremse Systeme Fuer Nutzfahrzeuge GmbH v. Dana Corp., 133 F.Supp.2d 843, 861 (E.D. Va. 2001). Consistent with this view, in *York Products, Inc. v. Central Tractor Farm & Family Center*, 99 F.3d 1568 [40 USPQ2d 1619] (Fed. Cir. 1996), the Federal Circuit held that the use of the word "substantial" did not render a claim indefinite. Noting that the "patent discloses no novel use of claim words," the court accorded the word "substantially" its normal meaning, stating: "ordinarily, therefore, 'substantially' means 'considerable in . . . extent, . . . or largely but not wholly that which is specified.'" *Id.* at 1572-73; see also *LNP Eng'g Plastics, Inc. v. Miller Waste Mills, Inc.*, 275 F.3d 1347, 1354 [61 USPQ2d 1193] (Fed. Cir. 2001); *Seattle Box Co., Inc. v. Industrial Crating & Packing, Inc.*, 731 F.2d 818, 829 [221 USPQ 568] (Fed. Cir. 1984); *C.E. Equipment Co.*, 17 Cl.Ct. at 299 ("the term 'substantially' in patent claims gives rise to some definitional leeway. . . . Patentees may use these terms to avoid unduly limiting the modified word. Thus, the term 'substantially' may prevent avoidance of infringement by minor changes that do not affect the results sought and accomplished.").

In the instant case, there is no indication that the patent assigned a special meaning to the term "substantially," and, as such, the phrase "substantially instantaneously" simply means that the elevation of the pH is nearly instantaneous. The specification to the patent makes clear that the neutralizer intended to cause such a reaction is a caustic and that examples of such a caustic include "sodium hydroxide, potassium hydroxide, and mixtures thereof." Expert testimony at trial further verified that one knowledgeable in the art would know at least two other caustics that would produce the required elevation of the pH--magnesium hydroxide and barium hydroxide. Accordingly, the court concluded that the disputed language in claim 9 should be interpreted to refer to the elevation of pH that would occur upon the introduction of a caustic, giving as examples thereof sodium hydroxide, potassium hydroxide, magnesium hydroxide, barium hydroxide, and combinations thereof.

2. '800 Patent

At the outset, it should be noted that plaintiffs and defendant agreed as to the construction of various claims in the '800 patent. Based upon those agreements, the court construed the relevant claims, as follows:

Claim 1: "metal compounds"###"precipitated or suspended compounds of metal"

Claim 1: "selected from iron, manganese, aluminum, zinc, copper, lead, arsenic, and chromium"###"selected from iron, manganese, aluminum, zinc, copper, lead, arsenic, and chromium, either alone or in combination with themselves or other materials and in any initial form so long as they are precipitated or suspended"

Claim 1: "comprising"###"comprising at least"

Claim 1: "agitating the waste water"###includes agitation by any means, including by aeration and by a mixer

Claim 1: "flocculating agent polymer"###includes a polyelectrolyte

Claim 1: "a group consisting of cationic and anionic polymers"###limited to cationic and anionic polymers but includes any cationic or anionic polymer

Claim 2: "further dewatering the floccules separated in step (e)"###"processing the floccules separated in step (e) in a second or later stage"

Claim 9: "polishing means"###limited to a polishing pond, a settling pond, and a polishing tank, and their equivalents

Claim 21: "used for primary clarification purposes"###"in a first stage clarifier"

Claim 22: "used for settling purposes"###"in a settling pond or tank"

Regarding the construction of the remaining claims in the '800 patent on which the parties disagreed, the rationale for the court's prior oral ruling is, as follows:

(i) Claim 1: "aerating the water."

[8] The court construed this phrase to mean "supply air and other gaseous oxidants to the waste water." Defendant argued that this element in claim 1 does not include forms of oxidation other than introducing air. However, the '497 patent, which is the preferred embodiment for this portion of the '800 patent, envisions the use of other gaseous oxidants (e.g., ozone). [FN11] As such, absent extraordinary evidence to the contrary (of which, there is none, let alone, clear and convincing evidence), the phrase "aerating the water," as used in the '800 patent, must be construed to include the preferred embodiment and, therefore, to cover the introduction not only of air, but other gaseous oxidants, into the waste water

stream. See Vitronics Corp., 90 F.3d at 1583 (a claim construction that would exclude the preferred embodiment "is rarely, if ever, correct and would require highly persuasive evidentiary support"); Hoechst Celanese Corp. v. BP Chems. Ltd., 78 F.3d 1575, 1580-81 [38 USPQ2d 1126] (Fed. Cir. 1996) (refusing to adopt a claim construction of "stable" that would exclude the preferred embodiment disclosed in the specification); see also Rexnord Corp. v. Laitram Corp., 274 F.3d 1336 [60 USPQ2d 1851] (Fed. Cir. 2001) (citing cases). This construction is bolstered by several dictionary definitions of the term "aeration." See, e.g., The American Heritage Dictionary of the English Language 3 (4th ed. 2000) ("[t]o supply or charge (liquid) with a gas"). Based on this evidence, the court need not tarry and rejects defendant's cramped interpretation of this element.

- (ii) Claim 1: "about 50 gal./min. to 500 gal./min." and
"about 50 mg./l. to
about 1,000 mg./l."

As discussed above, the court believes that these ranges, when viewed in conjunction with *1132 the ranges of dissolved oxygen concentration indicated in the patent, allow for the calculation of a rate of aeration and are not intended as limits on the patent involving certain flow rates or metal concentrations. Apart from the prosecution history discussed above, further indication of this may be found in the example in the specification, which refers to a waste water stream having a "dissolved metal concentrations of 10,000 ppm." Were defendant correct, the example, which corresponds to 10,000 mg./l., would be outside the limits supposedly prescribed in claim 1--a construction, however, that would be disfavored. See *Vitronics*, 90 F.3d at 1583.

- (iii) Claim 23: "adding in a dilute concentration of from
about 0.5% to about
1.5% by weight."

At the Markman hearing, this court reserved ruling on defendant's assertion that this claim is indefinite. Defendant offered two reasons for its assertion: First, it noted that the phrase "added in dilute concentration" does not specify at what stage in the method the polymer is being added. According to defendant, the claim also fails to specify whether the cited concentration refers to the dilution of the polymer prior to being added to the waste water or to the concentration of the polymer in relation to the waste water stream. Second, defendant again demurred to the use of the word "about," indicating that usage deprives the range of any specificity. Plaintiffs countered that the patent, at various points, specifies the addition points for the polymers and that one skilled in the art would know that the dilute concentration refers to the dilution of the polymer prior to being added to the system. They further contended that one skilled in the art would know that some level of experimentation would be required to select the proper polymer, dosage and dilution to deal with a particular waste stream.

Claim 1, on which claim 23 is dependent, indicates that the "flocculating agent polymer" is added to the waste water after the pH of the water is adjusted and the water is aerated and agitated. Consistent with this claim, the accompanying Figure 1 depicts a polymer tank 24 that eventually connects with rotary drum 22, immediately after the water leaves the reaction tank in which it is neutralized and aerated. To be sure, claim 2

of the patent, which is also dependent on claim 1, describes a process whereby there is further dewatering of the flocules separated in claim 1, and claim 3, which is dependent on claim 2, describes the method of claim 2 "wherein additional flocculating agent polymer is added to at least a portion of the waste water." Likewise, claim 11 effectively is dependent on claim 1 and describes a method where "additional flocculating agent polymer is added after the clarifier and then again after the rotary drum thickener." But, significantly, claim 23 is neither dependent upon claim 2 or 3, nor claim 11, and thus does not incorporate the possibility of a second point for the introduction of the polymer. As such, in the court's view, one skilled in the art would know where the polymer referred in claim 23 was to be introduced in the method described by claim 1.

Image 3 (4.25 X 4.75) Available for Offline Print

[9] In addition, the court rules that the dilution referred to in claim 23 is that of the polymer before, rather than after, it is added to the waste water stream. This conclusion most naturally proceeds from the language of the claim which refers to the polymer being added "in a dilute concentration of from about 0.5% to about 1.5% by weight." Indeed, nothing in the patent or its prosecution history suggests any limitations addressed to the weight of polymer that would be added into the waste water stream. Moreover, various extrinsic evidence offered by the parties, including expert testimony, indicates that polymers are traditionally marketed in concentrated form and each comes with a recommended dilution rate--the amount of water to be added before the polymer is used. Dr. Roth testified that the range of dilution specified in claim 23 was a "typical range" for diluting polymers. This industry practice, of course, is consistent with *1133 interpretation of this claim that specifies the dilution of the polymer before it is added to the waste water. Defendant has not provided clear and convincing evidence to the contrary.

Finally, for reasons similar to those described above, the court also does not believe that the use of the term "about" renders claim 23 indefinite. Rather, the court believes that one skilled in the art would view the term "about" as indicating "approximately."

* * * * *

That ends this phase of our journey. With these definitional building blocks in place, the court moves to defendant's arguments challenging the validity of the

subject patents.

III. VALIDITY OF PATENTS

We begin with familiar fare: patent claims are presumed valid, 35 U.S.C. § 282 (2001), and the burden of establishing to the contrary rests on the party asserting invalidity, who must prove the facts supporting invalidity by clear and convincing evidence. See *Georgia-Pacific Corp. v. United States Gypsum Co.*, 195 F.3d 1322, 1330 [52 USPQ2d 1590] (Fed. Cir. 1999), cert. denied, 531 U.S. 816 (2000); *Massey v. Del Labs., Inc.*, 118 F.3d 1568, 1573 [43 USPQ2d 1367] (Fed. Cir. 1997). The court will consider defendant's challenges to the validity of the '497 and '800 patents *seriatim*.

A. '497 Patent

Defendant contends that the claims of the '497 patent fail to meet various statutory requirements in the Patent Act. Specifically, it asserts that claims 1 and 2 of the '497 patent are invalid on grounds of obviousness under 35 U.S.C. § 103(a), and that claims 3 through 9 of the '497 patent are invalid not only for obviousness, but also for lack of enablement under 35 U.S.C. § 112 ¶ 1.

1. Is the '497 Patent Obvious?

A patent is invalid for obviousness when differences between its claims and the prior art "are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art." 35 U.S.C. § 103(a) (2000). While the ultimate determination whether an invention would have been obvious is a question of law, this conclusion is based on the totality of the evidence and informed *vel non* by four underlying factual inquiries: (1) the scope and content of the prior art; (2) the level of ordinary skill in the prior art; (3) the differences between the claimed invention and the prior art; and (4) any objective evidence of nonobviousness, such as long felt need, commercial success, the failure of others, or copying. See *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17-18 [148 USPQ 459] (1966); *Brown & Williamson Tobacco Corp. v. Phillip Morris, Inc.*, 229 F.3d 1120, 1124 [56 USPQ2d 1456] (Fed. Cir. 2000). The so-called Graham factors guide in determining "whether the prior art would have suggested to one of ordinary skill in the art that this process should be carried out and would have a reasonable likelihood of success, viewed in the light of the prior art." *Brown and Williamson Tobacco Corp.*,

229 F.3d at 1124 (quoting *In re Dow Chem.*, 837 F.2d 469, 473 [5 USPQ2d 1529] (Fed. Cir. 1988)). Defendant must prove these factual predicates by clear and convincing evidence. See *Newell Cos., Inc. v. Kenney Mfg. Co.*, 864 F.2d 757, 767 [9 USPQ2d 1417] (Fed. Cir. 1988), cert. denied, 493 U.S. 814 (1989); *Estate of Wicker*, 43 Fed.Cl. at 181.

Defendant asserts that the critical elements in the claims of the '497 patent were all shown in the prior art and that it would have been obvious to one skilled in the art in January 1986 to alter or combine the prior art so as to produce the '497 patent. The court will analyze these assertions, and plaintiffs' responses thereto, in the context of the four Graham factors identified above. See *Ruiz v. A.B. Chance Co.*, 234 F.3d 654, 663-64 [57 USPQ2d 1161] (Fed. Cir. 2000) (noting the need for the court to make specific findings with respect to the four Graham factors in determining obviousness).

(i) The scope and content of the prior art

The scope of the relevant prior art includes that "reasonably pertinent to the particular problem with which the inventor was involved." *In re GPAC Inc.*, 57 F.3d 1573, 1577 [35 USPQ2d 1116] (Fed. Cir. 1995) (quoting *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1535 [218 USPQ 871] (Fed. Cir. 1983)). "References that are not within the field of the inventor's endeavor may also be *1134 relied on in patentability determinations, and thus are described as 'analogous art', when a person of ordinary skill would reasonably have consulted those references and applied their teachings in seeking a solution to the problem that the inventor was attempting to solve." *Id.* at 1578 (quoting *Heidelberger Druckmaschinen AG v. Hantscho Commercial Prods., Inc.*, 21 F.3d 1068, 1071 [30 USPQ2d 1377] (Fed. Cir. 1994) (citation omitted)); see also *Harmon* at § 4.4, p.158. With respect to prior art, "[w]hile a reference must enable someone to practice the invention in order to anticipate under § 102(b), a nonenabling reference may qualify as prior art for the purpose of determining obviousness under § 103." *Symbol Technologies, Inc. v. Opticon, Inc.*, 935 F.2d 1569, 1578 [19 USPQ2d 1241] (Fed. Cir. 1991).

In the case sub judice, defendant challenges claim 1 of the '497 patent as obvious, advancing that every element thereof is found in the prior art references of U.S. Patent No. 4,652,381 ("Inglis"), U.S. Patent No. 4,240,990 ("Inhofer"), and Design Manual: Neutralization of Acid Mine Drainage, published by the EPA in January, 1983 (the "EPA Manual").

Likewise, defendant asserts that claim 2 of the '497 patent is obvious because of the prior art reference of In-Line Aeration and Treatment of Acid Mine Drainage, United States Department of the Interior Bureau of Mines Report of Investigations number 8868, by T.E. Ackman and R.L.P. Kleinman, published in 1984 ("Ackman"). Finally, defendant asserts that claims 3 through 9 of the '497 patent are obvious in light of Inglis, Inhofer, and the EPA Manual.

While plaintiffs admit that the references cited by defendant are prior art, they assert that art is not analogous. Per contra. Based upon the testimony received, the court concludes that the referenced prior art would have been consulted by a person of ordinary skill attempting to solve the problem surmounted by the '497 patent. For example, while Inglis does not involve mine waste water treatment, it does involve the treatment of industrial waste water contaminated by metals to lower the concentrations thereof to levels permitting discharge of the water to a sewer. Moreover, the contaminating metals involved in Inglis--lead, iron, copper and zinc--are among those covered by the '497 patent. Similarly, Ackman discusses the treatment of acid mine drainage using aeration, a concept that various witnesses confirmed is related to the '497 patent. Indeed, Ackman acknowledged the contributions of Messrs. Simonetti and Kanzleiter, two of the inventors of the '497 patent, for their role in developing aeration devices for treating mine waste water. Based on this evidence and other evidence in the record, the court concludes that the prior art identified by defendant is analogous and thus relevant to the obviousness inquiry here.

(ii) The level of ordinary skill in the prior art

The person of ordinary skill in the art is a legal construct--a hypothetical person who is placed in the position of being aware of all of the relevant prior art. Custom Accessories, Inc. v. Jeffrey-Allan Industries, Inc., 807 F.2d 955, 962 [1 USPQ2d 1196] (Fed. Cir. 1986). In determining this individual's level of skill, a court may consider several factors, including the kinds of problems existing in the art, the known solutions to the problems, the rate at which new inventions are made in the field, the complexity of the technology and the educational level of active workers in the field. Id.; see also Gargoyles, Inc. v. United States, 32 Fed.Cl. 157, 165 [42 USPQ2d 1760] (1994), aff'd, 113 F.3d 1572 [33 USPQ2d 1595] (1997). Not all such factors may be present in every case, and one or more of them may predominate. Custom Accessories, 807 F.2d at

962-63; see also In Re GPAC, Inc., 57 F.3d at 1579. Notably absent from this list is the level of skill of the inventors of the patents, which is generally not determinative. See Helifix Ltd. v. Blok-Lok, Ltd., 208 F.3d 1339 [54 USPQ2d 1299] (Fed. Cir. 2000); Custom Accessories, 807 F.2d at 962.

According to the expert testimony in this case, a person of ordinary skill in the art with respect to the '497 patent and analogous prior art would be one who has a combination of training and experience that allows him or her to understand the various processes that are described in the patent, including pH adjustment, oxidation, aeration, mixing, sedimentation, and solids de-watering. Such an individual could be one with ordinary skill in the art even if he or she understood these processes not in the context of mine waste water, but in dealing with other forms of industrial and municipal waste water. One skilled in the art, however, would know that the constituency and *1135 concentrations of metals in acid rock drainage can fluctuate at a particular site and, assuredly, is different from site to site. As such, testimony confirmed that such an individual would be able to conduct laboratory analysis (e.g., bench scale tests or jar tests) designed to fine tune the chemistry that would be needed to deal with a particular waste stream. According to that testimony, the ability to conduct such testing, which could range, in duration, from several hours to several weeks, is essential to determining the optimum conditions for precipitating the metals, using a combination, in particular, of various neutralizers and polymers, and dilutions thereof. Finally, one skilled in the art would be knowledgeable about solubility curves based on thermodynamic equilibrium data and under which conditions precipitation would be optimum. [FN 12]

(iii) The differences between the claimed invention and the prior art

Although the four Graham factors indisputably form the skeletal framework of the obviousness analysis, the backbone of that analysis, certainly in the instant case, is the comparison of the claimed invention with the prior art. Graham, 383 U.S. at 17. Regarding this third, often decisive, Graham factor, the Federal Circuit has stated that "whether obviousness is established by combining the teachings of the prior art, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art." GPAC, 57 F.3d at 1581 (quoting Cable Elec. Prods., Inc. v. Genmark, Inc., 770 F.2d 1015, 1025 [226 USPQ 881] (Fed. Cir. 1985) (citation omitted)).

Reiterating this concept, the court more recently opined: "[w]hen a patent describes a new mechanical device that can be viewed as a new combination or arrangement of mechanical components, the legal conclusion of obviousness requires that there by some suggestion, motivation, or teaching in the prior art whereby the person of ordinary skill would have selected the components that the inventor selected and used them to make the new device." *C.R. Bard, Inc. v. M3 Systems, Inc.*, 157 F.3d 1340, 1351 [48 USPQ2d 1225] (Fed. Cir. 1998) (citing cases). In such circumstances, in order to find obviousness, the combined teachings of the prior art must suggest the improvements embodied by the invention. In *Re Sernaker*, 702 F.2d 989, 994 [217 USPQ 1] (Fed. Cir. 1983).

Claim 1. Relying principally on Mr. Dupon's testimony, defendant first asserts that every element of claim 1--starting with the source of acidic or metal-bearing water and ending with the effluent discharge pipe--is shown in Inglis except for two elements: the "power source means" and the "agitation means." [FN13] Defendant asserts that the addition*1136 of the latter two elements would have been obvious to one of ordinary skill in the art. Plaintiffs respond that major differences exist between claim 1 and Inglis and further contend that defendant has failed to provide any evidence that one skilled in the art would have combined Inglis with other prior art to remedy these deficiencies.

[10] The court finds that defendant has not shown, by clear and convincing evidence, that the critical elements of claim 1 of the '497 patent were all found in prior art. In particular, prior art did not envision the type of continuous flow treatment taught by the '497 patent, but instead employed versions of batch treatments. This is a major distinction. Describing the difference between a batch treatment and a continuous flow method, Mr. Dupon testified that "[a] batch treatment is differentiated from continuous flow in that water flowing into it -- a specific volume of water flows into the tank. And therefore, it reacts. Once reaction is complete, water is allowed then to exit." He further indicated that in continuous flow treatment "there is a continuous input to the reaction and a continuous output," noting that ordinarily water in such a system enters the system at the same rate that it exits.

According to various testimony, prior art employing a batch approach to treating waste water required much longer treatment resonance times, relied on some

degree of gradual settling and, consequently, required much larger containment vessels, often pond-like settling basins. Highlighting these distinctions between the prior art and the '497 patent, Mr. Simonetti, one of the inventors of the patent, testified:

In the typical treatment plants we had at Kitt Energy, and they are to this day still the typical treatment plant, there are relatively large basins that are used for aeration. They are, as I say, generally designed for about 30 minutes resonance time, perhaps as much as an hour or two hours resonance time.

By that I mean if you would take a massive volume of water coming into one of these basins, say 300 gallons per minute, and you would say 300 gallons per minute in 30 minutes would be 9,000 gallons. So you would have to have a vessel at least that size for this transfer. Typically they are much larger than that. . . [FN14]

Further bringing into relief the claim at issue and prior art, Mr. Dupon candidly admitted that prior to the '497 patent, he was unaware of a tank that employed a four-minute resonance time for treating acid mine drainage. Moreover, Mr. Roth convincingly testified that:

This patent describes a significantly improved process for treating acidic waste. It invents a one-stage process to neutralize and oxidize the acidic waste simultaneously, operates with greatly reduced resonance times which greatly reduces the size of the treatment tank needed, results in precipitant which are amenable to flocculation and removal, produces an effluent which can be discharged, can be portable tank,*1137 several orders of magnitude larger than the tank in the '497 patent. [FN15]

As the evidence unfolded, other significant differences between claim 1 of the '497 patent and the prior art became apparent. For example, Inglis relied upon resonance times that allowed for gradual settling, the recycling of water during the treatment, and the use of two different treatment tanks with separate pH adjustments--none of which features are found in claim 1. Moreover, Inglis did not teach use of an aerator in the same fashion as the '497 patent. In this regard, Mr. Dupon admitted that while the '497 patent describes agitation of the waste water by both injection of gas and an impeller, Inglis describes agitation only by gas injection.

Nor can other prior art references save this sinking ship. Striving mightily to plaster over the gaps between

Inglis and the '497 patent, defendant suggests that one skilled in the art would have also relied on teachings in Inhofer and the EPA Manual. To be sure, Inhofer describes an aerator for use in the treatment of water with a propeller, thereby disclosing, in the words of claim 1 of the '497 patent, an "aerator means having agitation means." Moreover, the EPA Manual summarizes various methods for treating acid mine drainage (principally those that include iron contaminants) that rely on neutralization and oxidation, including the use of continuous flow methods using large holding basins and settling ponds. However, apart from Mr. Dupon's conclusory testimony, defendant provided no evidence explaining why one skilled in the art would have found it obvious to combine these prior art references, that is, to employ an aerator like that in Inhofer in an apparatus equivalent to that described in Inglis, or to modify Inglis based upon the teachings in the EPA Manual to derive the treatment apparatus described in claim 1 of the '497 patent.

On this count, defendant's proof certainly is not the stringent showing of a suggestion, teaching or incentive to combine features that the Federal Circuit has required to demonstrate obviousness based upon the combination of elements found in various sources. See *In Re Sang Su Lee*, 277 F.3d 1338, 1343 [61 USPQ2d 1430](Fed. Cir. 2002) (citing numerous cases); *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d at 1125 ("a showing of a suggestion, teaching, or motivation to combine the prior art references is an 'essential evidentiary component of an obviousness holding"); *In re Rouffet*, 149 F.3d 1350, 1359 [47 USPQ2d 1453] (Fed. Cir. 1998). "This showing must be clear and particular," the Federal Circuit has stated, and "broad conclusory statements about the teaching of multiple references, standing alone, are not 'evidence.'" *Brown & Williamson Tobacco*, 229 F.3d at 1125. Of the two contrasting evidentiary standards in this quote--one describing what is required, the other what is inadequate--Mr. Dupon's views on combination more resemble the latter. They were altogether too broad and conclusory to carry the day. His report, seemingly mirroring defendant's overall approach to proving obviousness, suffers from a hale dose of 20-20 hindsight--offering little more analysis than that because the '497 patent combined these elements others skilled in the art would have done the same. But, this is precisely the ipse dixit so often rejected by the Federal Circuit in the past. On one such occasion, the court cautioned that it is improper, in determining whether a person of ordinary skill would have been led

to this combination of references, simply to "[use] that which the inventor taught against its teacher." *W.L. Gore*, 721 F.2d at 1553. Only by insisting upon this rigor can the court avoid entry into the "tempting but forbidden zone of hindsight," *Loctite Corp. v. Ultraseal Ltd.*, 781 F.2d 861, 873 [228 USPQ 90] (Fed. Cir. 1985), overruled on other grounds by *Nobelpharma AB v. Implant Innovations, Inc.*, 141 F.3d 1059 [46 USPQ2d 1097] (Fed. Cir. 1998). And here that rigor is lacking.

Claim 2. Regarding claim 2 of the '497 patent, defendant avows that the limitation added *1138 by that dependent claim--disposing the influent pipe closely adjacent to the aerator shaft discharge, whereby the 'relative general proximity' of the water source, neutralizing agent feed line discharge, and agitation means enhances the "efficiency of the reaction," and automated and metering control means--is explicitly suggested by Ackman. Defendant asserts that two co-inventors of the '497 patent had actual knowledge of Ackman and that CST's prototype reactor was designed to mimic Ackman's Venturi action and "swirling agitation."

Ackman describes an "In-Line Aeration and Treatment System" (ILS), which functions in an existing acid mine drainage pipeline, as follows:

The ILS consists of two off-the-shelf components: a jet pump . . . and a static mixer . . . Both components can be described as aeration and mixing devices. Jet pumps are simply nozzles that entrain air by Venturi action Water enters under pressure generated by the existing mine water discharge pump and is converted by the jet pump into a high-velocity stream. This stream then passes through a suction chamber, which is open to the atmosphere. If the system is being used for neutralization as well as aeration, the suction chamber also serves as the injection point for the neutralizing material Alternatively, the neutralizing material can be mechanically injected into the line by a metering pump anywhere before the ILS. After passing through the jet pump, the flow enters the static mixer The static mixer consists of 1-ft sections of pipe made of copolymer polypropylene resins, laminated together end to end with fiberglass. Inside each section is a 1-ft helix that forces the water to follow a spiral path Each helical unit was rotationally offset 90<<degrees>> from its neighbor, thereby interrupting the corkscrew every foot and enhancing the mixing action. Eight 1-ft sections were used, which provided the contact time of a normal 32-pipe because of the induced spiral flow.

Ackman also notes that because of problems that were experienced in the field test in injecting the neutralizer into the acid mine drainage pipeline, pilot scale tests were employed in which the jet pumps were used as an injection port--essentially simultaneously neutralizing and aerating the water.

While Ackman's teaching thus bears similarity to the new matter in claim 2, defendant seemingly turns a blind eye to the fact that claim 2 is a dependent claim, which, when combined with claim 1, has key features not found in Ackman. For example, as Mr. Simonetti pointed out, Ackman does not involve a reaction tank or automated metering and control. Moreover, claim 2 teaches the use of separate agitation means (e.g., aerator prop 16 near the aerator discharge point), which is not revealed in Ackman. Thus dependent claim 2 does not appear to be obvious. At all events, the shorter response to defendant's argument regarding claim 2 derives from the Federal Circuit's repeated holding that dependent claims are nonobvious under section 103 if the independent claim on which they depend is nonobvious. See *In Re Fritch*, 972 F.2d 1260, 1266 [23 USPQ2d 1780] (Fed. Cir. 1992); *In re Fine*, 837 F.2d 1071, 1076 [5 USPQ2d 1596] (Fed. Cir. 1988); *Hartness Int'l, Inc. v. Simplimatic Eng'g Co.*, 819 F.2d 1100, 1108 [2 USPQ2d 1826] (Fed. Cir. 1987). Such is the case here. This court's conclusion that claim 1 is nonobvious thus results in a finding that dependent claim 2 is also nonobvious.

Claims 3-9. In its post-trial brief, defendant asserts that claims 3-9 would have been obvious in light of Inglis, Inhofer and the EPA Manual. However, defendant presented no testimony at trial in support of this claim and instead relies exclusively on Mr. Dupon's supplemental expert report received at the Markman hearing, without further elaboration, [FN 16] The cited portion of Mr. Dupon's supplemental report, however, only covers claims 3 through 5, and does so not from the standpoint of obviousness, but rather anticipation. While the court is willing to extrapolate Mr. Dupon's anticipation arguments in comparing claims 3-5 to prior art, it is unwilling to extend those arguments to claims 6-9, which are not mentioned. Defendant's arguments with respect to these latter claims are deemed waived. [*1139 FN17]

Regarding claims 3-5 of the '497 patent, Mr. Dupon's supplemental report states:

Assuming that the "agitation means" is not limited to a propeller, that the influent pipe means has no particular structure inside the treatment tank, that the

"means for introducing" is a pump, that "generally the same point" means "in the same area of the tank," that either tank 28 or final treatment tank 50 count as means for receiving precipitants from said mixture, and that "substantially simultaneously" means "in the same area of the tank," Inglis anticipates claims 3, 4 and 5 of the '497 patent. If the agitation means is limited to a propeller, then the aerator shown in U.S. Patent No. 4,240,990 ("Inhofer") meets the requirements of both the aerator means and the agitation means.

For example, the patent indicates that "aerator means" is distinct from the "agitation means." Accordingly, even if the agitation means were not a propeller, a structure meeting the requirements of this element of the claim would, nonetheless, have to incorporate a separate "agitation means"--and Inglis does not. Further, Mr. Dupon assumed claim 5's reference to the neutralizer and the oxidant being introduced "substantially simultaneously" is spacial, i.e., in the same tank or basin. However, the dictionary reveals that the term "simultaneously" is actually temporal, and requires that the oxidant and the neutralizer be added at the same time, a feature not shared by Inglis. [FN 18] Indeed, defendant's assertions regarding claims 3-5 are mostly a rehashing of arguments that this court has soundly rejected in the context of defendant's attack on the validity of claims 1 and 2. [FN19]

In his expert reports, Mr. Dupon also attempted to match up the critical elements of claim 3 of the '497 patents with the teachings of the EPA Manual. But, like his testimony at trial, his reports overlook the fact that the methods described in the EPA Manual lack some of the key features in claim 3 of the '497 patent. For example, while the EPA Manual teaches the use of a submerged turbine aerator, it does not address the use of an aerator that has a separate agitation means and, in fact, characterizes submerged turbine aerators as being "less efficient." More critically, while the EPA Manual discusses a process flow line that moves the waste water to a neutralization and oxidation basin, it does not teach having neutralization and oxidation occur essentially simultaneously, by having the neutralizing agent feed line be disposed generally adjacent to the end of the aerator means. Indeed, as the accompanying figure reveals, while the EPA Manual method employs a "neutralization and oxidation basin," it also employs a separate lime sludge reaction basin. And, perhaps most fundamentally, the EPA Manual teaches the use of basins in a mine water treatment process, rather than the use of a combined treatment unit. Accordingly, contrary to defendant's assertions, there is a host of significant differences between the EPA Manual and

claim 3 of the '497 patent.

Image 4 (2.5 X 5.25) Available for Offline Print

(iv) Any objective evidence of

In an obviousness analysis, objective evidence of nonobviousness must be considered if present. In *re* GPAC, Inc., 57 F.3d at 1580. Such evidence includes the commercial success of the patented invention, whether the invention meets "long felt but unsolved needs" and the failure of others to produce alternatives to the patented claims. *Graham*, 383 U.S. at 17. Objective evidence is accorded substantial weight only where the proponent establishes a nexus between such evidence and the merits of the claimed invention. *GPAC*, 57 F.3d at 1580; *Stratoflex*, 713 F.2d at 1539; *B.E. Meyers & Co., Inc. v. United States*, 47 Fed. Cl. at 378 (Fed. Cl. 2000). "A prima facie case of nexus is generally made out when the patentee shows both that there is commercial success, and that the thing (product or method) that is commercially successful is the invention disclosed and claimed in the patent." *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 [7 USPQ2d 1222] (Fed. Cir. 1988), cert. denied, 488 U.S. 956 (1988).

In the instant case, neither party directly addressed this factor, with what evidence there is deriving from proof of other points. The meager testimony that was offered seemed to demonstrate that at least claim 1 of the '497 patent met a "long felt but unresolved need" by providing for a relatively compact, low-cost and efficient means for treating mine waste water. Mr. Simonetti, for example, testified that the apparatus described by the '497 patent constituted a major departure from prior apparatuses, which tended to be large immovable structures that incorporated large reaction tanks and basins.

Any other evidence in the record of commercial success and copying is weak, at best. Thus, while there was testimony that, in 1991 and 1992, CST was profitable, ultimately, it appears that plaintiffs sold or leased only about a dozen or so PIT systems and there is no information at all that would allow this court to conclude that the numbers sold or leased were a substantial quantity in the relevant market. [FN20] Moreover, plaintiffs provided*1141 no evidence whatsoever that the apparatus described by the '497 patent was copied by anyone. Accordingly, this court concludes that there is essentially no objective evidence of nonobviousness that bears on the validity of the '497 patent.

2. Redux

A latent subtext underlies all defendant's obviousness arguments--that its evidence of obviousness was so self-evident, so overwhelming, that the burden effectively shifted to plaintiffs to prove validity. But the record evidence suggests that defendant's gem does not quite sparkle with the lustre advertised. While there are some striking similarities between claim 1, *Inglis* and other prior art, there are just as glaring distinctions and, critically, no concrete indication that one skilled in the art would have known to combine the various features of other prior art with *Inglis* to derive claims equivalent to the '497 patent. That the teachings of these various references may be cobbled together to produce an invention similar to claim 1 of the '497 is not enough, as it cannot be gainsaid that "virtually all inventions are combinations and virtually all are combinations of old elements." *Environmental Designs, Ltd. v. Union Oil Co. of California*, 713 F.2d 693, 698 [218 USPQ 865] (Fed. Cir. 1983). Having concluded that claim 1 is not obvious, it follows, for the reasons described above, that dependent claim 2 is also not obvious. Finally, based on its review of the *Graham* factors, the court concludes that one skilled in the art would have found that claims 3-5 of the '497 patent are distinct from prior art and thus also not obvious. The meager and glancing objective evidence of obviousness/nonobviousness in the record does not impact any of the court's conclusions. Hence, the court finds that defendant has fallen far short of proving, by clear and convincing evidence, that any of the claims in the '497 patent are obvious.

B. '800 Patent

The next stop on our journey involves the '800 patent. Defendant asserts that the claims of that patent are invalid for violating various provisions of sections 102 and 103 of the Patent Act.

1. Background

Reserving more extensive detail for the ensuing discussion of the party's arguments, what follows is a rapid summary of a somewhat lengthy trial record:

Prior to April 1992, CST had installed and operated a number of waste water treatment systems similar, if not identical, to the PIT System. One of these systems treated a fly-ash drainage pond at Penelec's Keystone Power Generation Station (Keystone), located in Indiana, Pennsylvania. This system removed iron and

manganese from the waste stream in sufficient quantities to bring the concentrations of these metals below EPA limits. Furthermore, it also removed significant amounts of aluminum from the waste stream.

On April 14, 1992, CST formally offered to sell a waste water treatment system utilizing the PIT System to Summitville Consolidated Mining Company ("Summitville"), a subsidiary of Galactic Resources, Inc., to remove copper from waste water produced at its gold mine in Summitville, Colorado. Summitville accepted this offer on April 24, 1992, and a purchase order was signed by an agent of Summitville on May 5, 1992. A PIT System was installed at the Summitville site on July 15, 1992. This system was licensed and built to treat approximately 100 gallons of water per minute and to precipitate out approximately 40 pounds of copper per day. For reasons the parties dispute, the polymer mix at the Summitville PIT System site was later readjusted by Mr. Stevenson and the site was operating satisfactorily by no later than late August, 1992. Thereafter, on May 25, 1993, the application that resulted in the award of the '800 patent was filed.

According to plaintiffs, the system needed at the Summitville site was fundamentally different than the one previously installed at the Keystone site, because the latter system was incapable of dealing with the copper-laden waste water produced at Summitville. In an effort to develop a polymer method that would deal with nonferrous pollutants such as copper, Mr. Stevenson allegedly engaged in an additional round of experimentation that was not completed until August 5, 1992. As such, plaintiffs allege that what they sold to Summitville in the spring of 1992 was an unfinished water treatment system, lacking the specific chemical process for removing non-ferrous metals, including the specific polymers, dilution, dosage or injection points to be used to effect the removal of non-ferrous minerals. As prime evidence of this, they point *1142 to a letter from Penny McPherson, the environmental manager at the Summitville mine, to the Colorado Departments of Natural Resources and Health, dated August 31, 1992. This letter, plaintiffs claim, suggests that the specific polymer mix was not conceived until August of 1992. [FN21]

2.The On-Sale Doctrine--Ready for Patenting

An issued patent is invalid if "the invention was . . . on sale in this country, more than one year prior to the date of the application for patent in the United States, . . ." 35 U.S.C. § 102(b). The sale of the invention,

which case law makes clear includes an offer for sale, must be for commercial gain and not merely for experimental use. See, e.g., *D.L. Auld Co. v. Chroma Graphics Corp.*, 714 F.2d 1144, 1150 [219 USPQ 13] (Fed. Cir. 1983). The ultimate determination whether an invention was on sale within the meaning of section 102(b) is a question of law, based on the underlying facts. See *Tec Air, Inc. v. Denso Manufacturing Michigan, Inc.*, 192 F.3d 1353, 1358 [52 USPQ2d 1294] (Fed. Cir. 1999); *Weatherchem Corp. v. J.L. Clark, Inc.*, 163 F.3d 1326, 1332 [49 USPQ2d 1001] (Fed. Cir. 1998).

In *Pfaff v. Wells Electronics, Inc.*, 525 U.S. 55 [48 USPQ2d 1641] (1998), the Supreme Court enunciated the now-familiar standard for applying the "on sale bar," holding that twin conditions must be met: "First, the product must be the subject of a commercial offer for sale. . . . Second, the invention must be ready for patenting." *Id.* at 67. The Court held that to demonstrate that an invention is ready for patenting a party could prove, *inter alia*, either that the invention was reduced to practice before the critical date or, "that prior to the critical date the inventor had prepared drawings or other descriptions of the invention that were sufficiently specific to enable a person skilled in the art to practice the invention." *Id.* at 67-68; see also *Vanmoor v. Wal-Mart Stores, Inc.*, 201 F.3d 1363, 1366 [53 USPQ2d 1377] (Fed. Cir. 2000), cert. denied, 531 U.S. 821 (2000). [FN 22] The Supreme Court further noted that it must be "clear that no aspect of the invention was developed after the critical date," 525 U.S. at 68, n. 14, explaining that "the word 'invention' must refer to a concept that is complete, rather than merely one that is 'substantially complete.'" *Id.*; see also *Space Systems/Loral, Inc. v. Lockheed Martin Corp.*, 271 F.3d 1076, 1080 [60 USPQ2d 1861] (Fed. Cir. 2001) ("Although conception can occur before the inventor has verified that his idea will work, . . . when development and verification are needed in order to prepare a patent application that complies with § 112, the invention is not yet ready for patenting.").

Applying the *Pfaff* test to the facts of this case requires defendant to establish two elements of the "on sale" defense by clear and convincing evidence, namely--(i) that there was a definite commercial sale or offer for sale of the invention claimed in the '800 patent more than one year before the plaintiffs filed their patent application; and (ii) that at the time of that sale or offer for sale, the invention was ready for patenting. See *Linear Technology Corp. v. Micrel, Inc.*, 275 F.3d 1040, 1047 [61 USPQ2d 1225] (Fed.

Cir. 2001). In ruling on the motion for summary judgment previously filed in this case, this court held that defendant had established the first of these prongs--that the PIT System, encompassing both an apparatus and chemical process, was on sale prior to the critical date of May 25, 1992. *Chemical Separation Technology, Inc. v. United States*, 45 Fed. Cl. 513, 517 [53 USPQ2d 1419] (1999). In this regard, this Court ruled that--

in advance of the critical date, plaintiffs had made an offer to Summitville, that offer had been accepted, a purchase order had been submitted by Summitville, and Summitville had made its first lease payments to Vision Financial, a leasing agent facilitating the transaction between CST and Summitville.

Id. [FN 23] In this court's view, "[t]he existence of these events is clear and convincing proof that the invention in question was subject to a commercial offer prior to the critical date." *Id.*; see also *Pfaff*, 525 U.S. at 67 (acceptance of purchase order makes clear that commercial offer made); *Weatherchem*, 163 F.3d at 1333 (signed purchase agreement evidence of commercial offer); *Evans Cooling Systems, Inc. v. General Motors Corp.*, 125 F.3d 1448, 1451 [44 USPQ2d 1037] (Fed. Cir. 1997) (discussing similar evidence of commercial offer), cert. denied, 522 U.S. 1115 (1998). [FN 24]

It remains to determine whether, at the time of that sale or offer for sale, the invention was ready for patenting. Interpreting this standard, the Federal Circuit has held that to be "ready for patenting" the inventor must be able to prepare a patent application, that is, to provide an enabling disclosure as required by 35 U.S.C. § 112. *Space Systems/Loral*, 271 F.3d at 1080-81; see also *Robotic Vision Systems*, 249 F.3d at 1313. As such, an invention is not ready for patenting if undue experimentation is required to allow one skilled in the art to practice the invention. See *Space Systems/Loral, Inc.*, 271 F.3d at 1080-81; see also *Genentech, Inc. v. Novo Nordisk A/S*, 108 F.3d 1361, 1365 [42 USPQ2d 1001] (Fed. Cir. 1997) ("To be enabling, the specification of a patent must teach those skilled in the art how to make and use the full scope of the claimed invention without 'undue experimentation.'"), cert. denied, 522 U.S. 963 (1997). This analysis must be applied to the patent on a claim-by-claim basis. In other words, the validity of each claim of a patent, even a dependent claim, is a separate consideration from the validity of any other claim, including the independent claim from which it springs. See *Lough v. Brunswick Corp.*, 86 F.3d 1113, 1122

n.5 [39 USPQ2d 1100] (Fed. Cir. 1996) ("[e]ach claim of the patent must be considered individually when evaluating a public use bar."), cert. denied, 522 U.S. 806 (1997). *1144 25% Although the burden of proving that the invention was ready for patenting lies squarely on the defendant, it is helpful to review the record evidence bearing on this prong of the inquiry through the prism of the plaintiffs' contentions.

First, plaintiffs claim that critical aspects of "polymer chemistry" in the '800 patent, such as the polymers chosen, as well as the injection concentrations, resonance times, and injection points, were not patentable until Mr. Stevenson completed his work at the Summitville site in August of 1992. They assert that while the PIT System at Keystone successfully removed iron, manganese, and aluminum from the waste stream, prior to Mr. Stevenson's August of 1992 experimentation, one skilled in the art would have been unable to employ the same method to treat a waste stream whose primary constituent was copper. To evaluate these assertions, the court must examine the differences, if any, between the claims of the '800 patent and what was reduced to practice or otherwise ready for patenting before the critical date. See *Pfaff*, 525 U.S. at 66, n. 12; *Scaltech*, 269 F.3d at 1384 (holding that the process offered for sale must inherently possess each of the claim limitations of the patented process in order to establish an on-sale violation). This inquiry, in turn, requires the court to return to the elements and claims of the patent, as construed by this court under the Markman process.

At the outset, the court ascribes considerable significance to the fact that claim 1 of the '800 patent only teaches three basic things regarding the patent's polymer chemistry--that flocculating agent polymers should be used in the process, that such polymers must either be "cationic" or "anionic," and that they are to be employed to allow floccules to form to separate the metal compounds from the water. Ever so slightly expounding on this claim language, the specification merely supplies several examples of suitable polymers, stating that "NALCO 7767 is a suitable commercially available anionic polymer," and that "[c]ationic polymers may be used for dewatering purposes and may be selected from the following commercially available polymers: PERCOL AC 737 and UNIFLOC 630." Taken together, then, claim 1 and the associated portions of the specification provide virtually no detail as to the specific polymers to be used in the '800 patent, their concentration and resonant times, and reveals only a single injection point after the waste water is neutralized, aerated and agitated. Accordingly, in order

to establish that claim 1 of the '800 was ready for patenting before the critical date, defendant needed only to show, albeit by clear and convincing evidence, that the pre-critical date version of the PIT System introduced a cationic or anionic polymer to form floccules at some point after the neutralization, aeration and agitation of the water.

[11] Defendant convincingly met this burden through the testimony of none other than Mr. Stevenson, who indicated that the type of polymer being used in the PIT System on January 28, 1991, was a cationic polymer used for various flocculation purposes. He testified:

Q Which [polymer] was in use on January 28th, 1991?

A I don't remember.

Q Was it Percol-737 or Percol-730?

A It was a cationic polymer.

Q Once the polymer was added to the rotary thickener, floccules including said metal compounds formed, right?

A Yes.

Q And then inside the rotary thickener, those floccules were separated from the water, right?

A Some of them. Yes. Yes, they would have separated there. Yes.

Q And the Keystone Plant also added polymer upstream of the belt filter press, right?

A That's correct.

Q And that polymer was also a cationic polymer, is that right?

A That's correct.

Q: The CST reactor agitated the waste water, didn't it?

A: That's correct.

***1145** Q: And the CST reactor aerated the waste water, right?

A: That's correct.

Q: And the CST reactor aerated the waste water so as to oxidize the iron, right?

A: That's correct.

Q: And then you added a flocculating agent polymer in the rotary thickener, right?

A: That is correct.

This testimony, standing alone, justifies the conclusion that the polymer addition step in claim 1 of the '800 patent was ready for patenting prior to the critical date.

Yet, a wide range of documentary evidence serves to corroborate this conclusion. For example, CST's 1989 business plan described Keystone as using CST's "sludge dewatering facility," and included a drawing which showed a reactor, rotary thickener, belt filter press and a polymer unit for injecting polymer upstream of both the rotary thickener and belt filter press. Further, a Technology Review of the CST process, dated May 4, 1990, noted that the PIT System incorporated the '497 patent and added flocculent before the sludge treatment plant, which consisted of a rotary drum thickener and belt press. Finally, and perhaps most telling, the Keystone plant was described, in detail, in a report prepared by Mr. Zeising describing what he saw when he visited the Keystone plant in late January of 1991. This report indicates that, as of that time, the Keystone plant was successfully using the process of claim 1 to remove iron and manganese (a conclusion also supported by the results of water samples taken by Mr. Stevenson a week before Mr. Zeising's visit). Mr. Zeising visited the plant and observed, in operation, the reactor vessel, hydroxide formation, and flocculent addition, as well as the use of a rotary sludge thickener and belt filter press. Accordingly, focusing first on the type and basic uses of the polymers reflected in claim 1 of the '800 patent, it is apparent, through clear and convincing evidence, that what is claimed was reduced to practice at the Keystone plant in advance of the critical date.

Plaintiffs, however, rejoin that it would not have been predictable to one skilled in the art that the pre-critical-date version of the PIT System method would effectively treat a waste stream whose primary constituent was copper. Readiness for patenting then, according to plaintiffs, could not have been achieved until after Mr. Stevenson had completed his

experimentation at the Summitville site because the flocculation chemistry for a non-ferrous-based waste stream was not reduced to practice prior to that time. Plaintiffs support this claim principally with the expert testimony of their expert, Dr. Roth. While defendant did not produce direct evidence showing that the PITS method could have treated a copper-laden waste stream prior to the critical date, it did produce clear and convincing evidence that copper can be removed from aqueous solution with a simple elevation in pH. Indeed, Dr. Roth admitted that removal of copper from water was well known in the art prior to 1993 and that such removal could be obtained simply by changing the pH without normally applying aeration or flocculation. In addition, defendant produced clear and convincing evidence, including the testimony of Mr. Stevenson, that the PIT System at the Keystone site was, in fact, removing copper prior to the critical date, at least in trace amounts, via co-precipitation with iron. Based on this evidence, the court finds that, to the extent it was to be used to treat a copper-laden waste stream, claim 1 was ready for patenting before the critical date.

While Mr. Stevenson swore, contrariwise, that "the last piece of the puzzle" involving the '800 patent method was not in place until August of 1992, the court finds his testimony utterly incredible for several reasons. First, there is clear and convincing evidence that the Summitville PIT System was effectively removing copper from the waste stream at its start-up, and that Mr. Stevenson's experimentation was necessitated not by the need for additional development of the process' chemistry, but rather by the fact that the Summitville PITS had been damaged or altered after its initial installation. This finding is confirmed by Mr. Stevenson's prior deposition testimony, various correspondence from Mr. Stevenson predating the critical date discussing the Summitville contract, and a July 15, 1992, report on Summitville, that indicated the method was already removing copper to EPA limits. [FN 26] Second, when pressed, Mr. Stevenson *1146 could not provide any exegetic details of the aspects of the patent that were developed during his experimentation or even what that experimentation entailed. Indeed, Mr. Stevenson's somewhat sketchy testimony strongly suggests that the experimentation he conducted was not fundamental at all, but rather the type of bench- and field-testing that typically would be conducted by one skilled in the art to adjust the pH level and polymer usage to optimize the treatment of a particular waste stream. There is no indication that this experimentation was anything other than the sort of fine tuning that plaintiffs, in the

Markham hearing, successfully argued did not render claims indefinite. Finally, were this experimentation ground-breaking in its treatment of a waste stream that included copper--and there is clear and convincing evidence in the record that it was not--it remains that nothing of this ground-breaking chemistry is reflected in claim 1 of the patent or, for that matter, any of the other claims therein.

As such, this court finds that the government succeeded in establishing, via clear and convincing evidence, that the method of Claim 1 of the '800 patent was ready for patenting at the time the PIT System was sold to Summitville, despite the fact that it previously had not been used to treat copper- predominated waste streams. Because, as this court previously determined, the invention that is described by claim 1 was also the subject of a sale prior to the critical date, claim 1 is hereby held invalid under section 102(b). That leaves claims 2 through 25 in the '800 patent. These dependent claims modified the method in claim 1 in various fashions, some describing different introduction points and uses for a polymer, several referring to the use of a polishing pond, and a number positing various steps dependent upon the addition of a clarifier to the process. *1147 27%

The foregoing evidence demonstrates conclusively that a number of these dependent claims were also "ready for patenting" before the critical date. Specifically, based on the evidence produced regarding Keystone, the court finds that dependent claims 2, 3, 4, 20, 21 and 25, which relate to the use of cationic and anionic polymers in dewatering, including the use of a belt filter press, were reduced to practice and ready for patenting. In addition, record evidence indicates that claims 18, 19 and 23 were also ready for patenting, as the method reduced to practice at Keystone included steps whereby the waste water was neutralized to a pH between 6 and 9 using sodium hydroxide, and whereby a polymer with a dilute concentration of from about 0.5 percent to about 1.5 percent (actually 1 percent) was employed. Finally, as there is clear and convincing evidence that Keystone also employed a polishing pond, claims 5 and 24 of the '800 patent were also reduced to practice prior to the critical date. Summarizing then, the evidence that demonstrates that claim 1 was "on sale" prior to the critical date, also demonstrates, to the same degree, that claims 2-5, 18-21 and 23-25 were "on sale" and thus are invalid.

Defendant also asserts that claims 6, 7 and 10 were ready for patenting prior to the critical date. It admits that these claims were not practiced at Keystone, as

that plant made no use of a clarifier and first stage separation occurred only in a rotary thickener. Nonetheless, defendant provided clear and convincing evidence that the use of a clarifier, as part of the overall process and, specifically, in conjunction with a rotary thickener, was conceived prior to the critical date. In particular, CST's 1991 business plan contains a figure that depicts the use of a clarifier in conjunction with the PIT System then in use at the Keystone plant. See *Scaltech*, 269 F.3d at 1331 (holding that invention was ready for patenting because "the inventor had prepared drawings or a description sufficient for enablement"). That this drawing was an enabling description that would have allowed one skilled in the art to practice claims 6, 7 and 10 of the '800 patent without undue experimentation is confirmed by the fact that Mr. Stevenson offered these features to Summitville and was able to start up the PIT System with these features already intact in July of 1992--prior to the time that he allegedly conducted the experimentation that led to the "refinement" of the method. Moreover, it bears repeating that the record discloses that Mr. Stevenson was required to conduct that further experimentation not because of the need to develop these features in the patent, but because the PIT System was damaged or modified subsequent to its installation, causing it to malfunction. Accordingly, the court finds, based upon clear and convincing evidence, that claims 6, 7 and 10 were also "on sale" prior to the critical date and thus are invalid.

In a last ditch effort to salvage both claim 1 and the succeeding dependent claims from the "on sale bar," plaintiffs argue that, the Summitville site was experimental in nature -- making this assertion not to contest this court's earlier conclusion that the sale to Summitville was commercial, but rather as circumstantial evidence that the various claims of the '800 patent were not ready for patenting. Of course, a direct response to this assertion is that the facts show that these claims were reduced to practice. See *Zacharin v. United States*, 213 F.3d at 1369; *RCA Corp. v. Data Gen. Corp.*, 887 F.2d 1056, 1061 [12 USPQ2d 1449] (Fed. Cir. 1989). That aside, the nature of the Summitville contract, and the negotiations that led thereto, only serve to confirm this court's conclusion that many of the claims of the '800 patent were ready for patenting.

The first evidence of this may be found in the communications leading up to the sale. For example, in a letter he wrote to Summitville on April 3, 1991, Mr. John LeFever, a project manager for CST, represented that "[b]ased on the water quality data provided, we are

confident that we can remove the contained metals to acceptable standards for discharge."*1148 He indicated further that "[i]n the case of Summitville leachate solution, selective precipitation of copper and zinc as sulfides and sulfates can be achieved at a pH level of 5." Subsequently, on April 14, 1992, Mr. Stevenson wrote Summitville to describe the "design criteria" for the project, among them, that the influent waste water, at worst, would contain 190 mg./l. of copper. This letter also described in detail the equipment that CST would provide for the "budget price" of \$280,000. Two days later, on April 16, 1992, Mr. Stevenson wrote Summitville, stating that the "effluent discharge quality" at the site should be less than 1 ppm for iron, manganese, and zinc, and, significantly for our purposes, less than 0.1 ppm for copper. In this letter, Mr. Stevenson further represented that "[h]istorically we have experienced metal discharge ranges in the .002 mg/l (ppm) ranges and those limits could be achievable at the ADIT site." Nothing in these communications suggests the slightest doubt that the PIT System could remove copper from the waste water streams at Summitville.

Then, on May 15, 1992, Mr. Stevenson wrote Summitville two letters: the first describes in great detail the operational sequence of CST's treatment method and trumpets that "CST units are adaptable to alternate energy, oxidation and chemical inputs to treat and dewater most waste water discharges of acidic or alkaline." The second discusses the recovery of mercury, lead and cadmium from the Summitville site, indicating that "the above metals will experience some co-precipitation with Fe and Cu." The information contained in these letters was used by Summitville to prepare an "Interim Measure Report," dated May 15, 1992, for the Colorado Departments of Natural Resources and Health. The report apparently was key to the potential settlement of pending environmental claims filed by the state agencies against Summitville. It described in great detail the PIT System, with accompanying flow charts, and indicated that "[t]he process to be utilized in the treatment of flow from the property for reduction of copper and other metals . . . is a caustic soda (NaOH) precipitation process." The report restates the effluent concentration for copper and other elements supplied by CST and summarizes various assurances made by CST to Summitville, among them that the PITS "has been designed to remove a minimum of 44 pounds of copper per day for the entire year and to achieve higher copper loadings removal (i.e., an average 102 lb/day) for a significant portion of the operating season." Again, there is no hint in this report of any doubt that the PIT System

could remove copper--a fact that undoubtedly would have been relevant to the Colorado agencies--and, indeed, absolutely no indication in any of the CST correspondence that modification of the PITS to remove copper was still in an experimental stage.

To cinch matters, plaintiffs' claims regarding the Summitville site are also belied by the terms of the contract executed with respect to that site. First of all, it is telling that Summitville agreed to purchase outright from CST, through a sale/leaseback arrangement with a third party, the equipment necessary to treat its waste stream at a total price of \$288,400. Nothing in the purchase or sale/leaseback agreements conditions the sale upon CST's ability to actually be able to treat a copper-laden waste stream. This is further evidence that Summitville believed that it was purchasing what CST had unqualifiedly advertised--a completed process for treating its copper-laden waste water. Consistent with this view, there is not a shred of evidence in the record of any systematic testing of the system, the maintenance of records of such experimentation or other indications that CST maintained control over the reactor and its testing. See *Lough v. Brunswick Corp.*, 103 F.3d 1517, 1521 [41 USPQ2d 1385] (Fed. Cir. 1997); *Seal-Flex, Inc. v. Athletic Track & Court Constr.*, 98 F.3d 1318, 1323 [40 USPQ2d 1450] (Fed. Cir. 1996). Indeed, in an August 31, 1992, report to the Colorado state agencies described above, Summitville describes various problems that had occurred at its PITS site since July 15, 1992, attributing the delays not to any experimentation by CST, but to two other phenomena: (i) a lightning strike near the PIT System which overloaded the system's computer board and damaged the pH control probe; and (ii) the need to conduct polymer field testing. Regarding the second problem, the report indicates that the polymer field testing was conducted not by CST, but by a representative of Western Water Management, a polymer distributor. It notes that the polymer selected by Western "worked very well with the PITS effluent, providing excellent flocculation and sludge cake formation." *1149 This report concludes that "[o]nce the computer board had been replaced, the start-up problems had been ironed out and a polymer had been found that could be used with the PITS effluent as the make-up water, the PITS performed very satisfactorily." [FN 28] And it bears repeating that even before this field testing, the PIT System was removing copper--thereby already reducing to practice the step that plaintiffs assert required additional testing before being ready for patenting.

In sum, the court finds that the PITS method sold to Summitville inherently possessed each of the limitations of claim 1 of the '800 patent. While the court accepts that the method may have undergone some experimentation and refinement after the critical date, in the court's opinion, such experimentation, at most, constituted "fine tuning" of features not claimed in the patent. Similarly, the court concludes that the following dependent claims were also reduced to practice or otherwise ready for patenting prior to the critical date: claims 2-7, 10, 18-21, and 23-25. Together with claim 1, these dependent claims were both the subject of a commercial sale and ready for patenting in advance of the critical date and, therefore, under section 102(b), are invalid. As to these claims, the presumption of legitimacy has been overpowered, and the burden of showing them to be nugatory has been shouldered.

3. Defendant's Remaining Objections to the Validity of the '800 Patent

Defendant argues that the various claims in the '800 patent are invalid for other reasons. Thus, it contends no claim of the '800 patent is enabled, that various claims in the patent were anticipated by prior art and that every claim in the patent is obvious. The court will deal with each of these sets of arguments in turn.

a. Enablement

This next leg of our journey requires the court to consider whether various claims in the '800 patent were enabled. Under section 112, paragraph 1, of the Patent Act, patents must describe "the manner and process of making and using [the invention], in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains . . . to make and use the same." 35 U.S.C. § 112, ¶ 1 (1994). This provision requires the patent to disclose enough information so that one skilled in the art may make and use the full scope of the claimed invention without undue experimentation. *Process Control Corp. v. HydReclaim Corp.*, 190 F.3d 1350, 1358 [52 USPQ2d 1029] (Fed. Cir. 1999), cert. denied, 529 U.S. 1037 (2000). One of the grounds for finding nonenablement arises when a claimed method reads on nonoperative as well as operative embodiments--as defendant describes in its brief, "a genus is claimed, but only a species is enabled." This scenario is particularly encountered in patents concerning chemical reactions and biological activity. For example, in *In Re Goodman*; 11 F.3d 1046 [29 USPQ2d 2010] (Fed. Cir. 1993), the claim covered a method for producing "mammalian peptides

in plant cells," but was enabled only with respect to the production of peptides in "dicotyledonous plant cells," not all plant cells, Id. at 1050-52. [FN 29] As with its other validity arguments, defendant must demonstrate the facts underlying its enablement assertions by clear and convincing evidence. *Union Pacific Resource Co. v. Chesapeake Energy Co.*, 236 F.3d 684, 692 [57 USPQ2d 1293] (Fed. Cir. 2001); *Fromson v. Advance Offset Plate, Inc.*, 755 F.2d 1549, 1555 [225 USPQ 26] (Fed. Cir. 1985).

Defendant asserts that the cardinal flaw in the '800 patent--one which invalidates all 25 claims--*1150 is that the patent claims to cover the removal of eight metals, either alone or in combination, from waste water, but is enabled only as to some of those combinations. Central to this argument is the allegation that arsenic or hexavalent chromium [FN 30] alone in solution, or together with no other materials present, will not precipitate if only the steps of claim 1 are performed. Defendant further asserts that the process of oxidation, as outlined in claim 1, cannot be accomplished if only certain metals are present in the waste stream. Finally, it contends that nothing in claims 2-25 remedies these problems, as those steps pertain to separation and have nothing to do with pH adjustment, oxidation or flocculation.

To a certain extent, and not surprisingly, there is tension between defendant, on the one hand, arguing that various of the claims in the patent were on sale, and, as such, ready for patenting, and, on the other, arguing that some of the same claims were not enabled. Either the claims are enabled or they are not. Plaintiffs' arguments, however, are not immune from these same "tensions"--thus, for example, while they vigorously argue that various claims in the '800 patent were not indefinite because one skilled in the art would know that various forms of bench and field testing would be required to make the process work on a particular waste stream, they deftly seek to recharacterize similar sorts of bench and field testing as being more fundamental in arguing that various claims were not ready for patenting. Certainly, consistent with modern forms of pleading, it is open to the parties to argue alternative theories--but there is only a single set of findings appropriate in this case, findings that are driven, in no small part, by the heavy evidentiary burden borne by defendant in seeking invalidation, to wit, the ever-present clear and convincing evidence standard. And regarding the issue at hand, this court finds that defendant has not shown, by clear and convincing evidence, that the claims in the '800 patent were not enabled.

To be sure, defendant's expert, Mr. Dupon, testified in great detail regarding the behavior of arsenic alone in waste water stream. He seemed to suggest, at one point, that no adjustment in the pH or oxidation of such a waste water stream would cause arsenic to precipitate and that it could be removed from the waste stream only if a coagulant were added to the water, such as iron or manganese. Mr. Dupon went on to make similar observations regarding the hexavalent form of chromium. Less than clear is what assumptions he made in rendering these opinions and, in particular, whether his opinion was tainted by those of his constructions of the patent which the court, in its Markman ruling, rejected. There are several indications that such a taint occurred. For example, in his testimony, Mr. Dupon seemed to persist in the notion that ozone and chlorine would not be used as oxidants, despite the fact that the patent had been construed to include potentially the use of such oxidants. Indeed, under cross-examination, he admitted that ozone could be used to oxidize arsenic, eventually leading to its co-precipitation. Similarly, Mr. Dupon seemed to assume that more unusual and perhaps expensive forms of neutralizers, for example, magnesium hydroxide and barium hydroxide, would not be employed, despite there being no limitation in the patent to exclude such neutralizers. [FN31] His testimony, at points, suggests that with less common oxidants and neutralizers, arsenic and hexavalent chromium could be precipitated using the method of the '800 patent. Further, on several occasions, Mr. Dupon's testimony seems to assume that the method described in claim 1 would have to occur using a pH adjustment precisely between 5 and 12, notwithstanding this court's ruling that the use of the term "about" in this element of claim 1 provides for some flexibility in *1151 assessing the specific pH that would optimize precipitation.

[12] More critically, Mr. Dupon testified that he was unsure whether he had ever encountered hexavalent chromium in a mine waste water stream and he further testified that, in his experience, acid mine waste waters would usually have multiple metal contaminants in fluctuating concentrations, thereby leaving the distinct impression that one would not find in nature a mine waste stream contaminated solely by arsenic and/or hexavalent chromium. This point is significant, as it is well established that a claim will not be invalid as nonenabled if it reads on subject matter that is inoperative "only on the basis of unreasonable assumptions or without limitations that would be implied by one with ordinary skill in

the art." 3 Donald S. Chisum, *Chisum on Patents*, § 7.03 [7] at 7-123 (2001). The fact then that claim 1 of the patent might not work with respect to an acid mine stream that is exceedingly rarely, if ever, encountered in nature thus does not provide a predicate for concluding that the claim is nonenabled. As the Federal Circuit noted in *Atlas Powder Co. v. E.I. du Pont de Nemours & Co.*, 750 F.2d 1569 [224 USPQ 409] (Fed. Cir. 1984): "Even if some of the claimed combinations were inoperative, the claims are not necessarily invalid . . . [I]f the number of inoperative combinations becomes significant, and in effect forces one of ordinary skill in the art to experiment unduly in order to practice the claimed invention, the claims might indeed be invalid." *Id.* at 1576-77. Here, like the Carrollian Jabberwock, the nonenabling examples cited by defendant's expert are more fiction than reality--to borrow defendant's phrase, such waste streams are nonexistent "species" of the "genus" treated by the patent. As such, they provide no basis for invalidating claim 1 of the patent. See *Ex parte Breuer*, 1 U.S.P.Q.2d 1906, 1906 (Bd. Pat. App. & Int'l 1986) ("The issue is not whether the examiner can conjure up a substituent group. . . which does not exist. A person having ordinary skill in the art would readily appreciate that compounds containing such substituent groups do not exist.")

Defendant's argument that dependent claims 2 through 25 of the patent were not enabled is contingent on its assertion that claim 1 was not enabled. As this court rejects the latter assertion, it follows that defendant's enablement arguments concerning the remaining claims of the '800 patent must also fail.

b. Anticipation

Continuing this odyssey, the court next considers whether the '800 patent was anticipated. Section 102(a) provides that "[a] person shall be entitled to a patent unless--(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent." Based on this section, it is well settled that a claim is anticipated, and thus invalid, if each and every limitation is found either expressly or inherently in a single prior art reference. See *Celeritas Technologies, Ltd. v. Rockwell International Corp.*, 150 F.3d 1354, 1361 [47 USPQ2d 1516] (Fed. Cir. 1988), cert. denied, 525 U.S. 1106 (1999); *Structural Rubber Prods. Co. v. Park Rubber Co.*, 749 F.2d 707, 715 [223 USPQ 1264] (Fed. Cir. 1984). "To establish inherency," the Federal Circuit recently stated, "the

extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill.'" In re Robertson, 169 F.3d 743, 745 [49 USPQ2d 1949] (Fed. Cir. 1999); see also *Continental Can Co. U.S.A., Inc. v. Monsanto Co.*, 948 F.2d 1264, 1268 [20 USPQ2d 1746] (Fed. Cir. 1991). Such inherency may not be established by "probabilities or possibilities." *Continental Can*, 948 F.2d at 1269 (quoting *In re Oelrich*, 666 F.2d 578, 581 [212 USPQ 323] (C.C.P.A. 1981)). Summing up these standards, the Federal Circuit has instructed that "if granting patent protection on the disputed claim would allow the patentee to exclude the public from practicing the prior art, then that claim is anticipated, regardless of whether it also covers subject matter not in the prior art." *Atlas Powder Co. v. Ireco, Inc.*, 190 F.3d 1342, 1346 [51 USPQ2d 1943] (Fed. Cir. 1999).

Although this court has already concluded that claim 1 of the '800 of the patent is invalid under the on-sale doctrine, it, nonetheless, will consider defendant's assertion that this claim is also anticipated because if it is not, then none of the other dependent claims in the patent (including those that are not invalid under the on-sale doctrine) are anticipated. See *RCA Corp. v. Applied Digital Data Sys., Inc.*, 730 F.2d 1440, 1446 [221 USPQ 385] (Fed.*1152 Cir. 1984), cert. dismissed, 468 U.S. 1228 (1984). Relying on claim charts in Mr. Dupon's expert reports, defendant charges that each of the elements in claim 1 of the '800 patent are found literally in the EPA Manual and Inglis. But, both Mr. Dupon's original expert report and his supplemental report caution that his conclusion that the EPA Manual and Inglis anticipate the claims of the '800 patent "depends on the interpretation of the claim language." Defendant avers that this caveat is irrelevant because, at trial, Mr. Dupon testified that this court's constructions of the patent had not changed his mind regarding whether the patent was anticipated. Defendant criticizes Dr. Roth's contrary's opinion, asserting, in part, that it was "wholly conclusory" and "in sharp contract to Mr. Dupon's thorough analysis." This court, however, adjudges Mr. Dupon's claim-chart analysis significantly less than "thorough" and entirely inadequate to meet defendant's burden of proving anticipation by clear and convincing evidence.

Particularly this is so, as careful review of the references cited by Mr. Dupon, as well as Dr. Roth's testimony, betrays clear differences between claim 1 of the '800 patent and what is taught in the EPA Manual and Inglis. For example, while claim 1 discloses that

the adjustment of the pH of the waste water, and the aeration and agitation thereof, should be "carried out simultaneously in a reaction tank," the EPA Manual teaches only that oxidation and neutralization should occur gradually in the same basin. Further, as Dr. Roth indicated in his expert report, the method for accomplishing the neutralization of the waste water in the method described in the EPA Manual relies on the introduction of a lime slurry and recycled sludge into the neutralization and oxidation basin--steps not found in claim 1 and, in the absence of which, the EPA Manual indicates that its method will not work. [FN 32] As to Inglis, Mr. Dupon's claim-chart is even more desultory, failing, for example, to supply a citation as to how Inglis, which describes a method for treating waste water from a lead acid battery manufacturing plant, "simultaneously" accomplishes the neutralization, aeration and agitation of the waste water. Moreover, Mr. Dupon failed to account for, either in his chart or his testimony, the possible differences in the pH levels relied upon by the two processes. Thus, while claim 1 of the '800 patent indicates that the pH level of the waste water should be adjusted to "from about 5 to about 12," the specification in Inglis appears to suggest that any pH adjustment in that process should cease when the pH of the waste water reaches "about 5." Without further elucidation, it is impossible for this court to determine what overlap one skilled in the art would perceive between these two steps, particularly since Mr. Dupon's expert reports took the view that the phrase "about 5," as used in the '800 patent, was indefinite--a position ultimately rejected by this court.

Given that Mr. Dupon explicitly conditioned his findings of anticipation upon interpretations of the '800 patent that were subsequently rejected, the court believes that his conclusory reaffirmation of his prior findings, [FN 33] without any explanation whatsoever of the impact of this court's Markman rulings, represents far too slim a reed upon which to declare the patent at issue is invalid. See *The Upjohn Co. v. Mova Pharmaceutical Corp.*, 225 F.3d 1306, 1311 [56 USPQ2d 1286] (Fed. Cir. 2000) ("there must be factual support for an expert's conclusory opinion"); *Union Carbide*1153 Corp. v. American Can Co.*, 724 F.2d 1567, 1572 [220 USPQ 584] (Fed. Cir. 1984) (refusing to credit "an unsupported conclusory opinion which ignored, rather than conflicted with, the evidence of record."). More fundamentally, while Mr. Dupon cites evidence that individual elements for treating acid mine water waste are scattered in the EPA Manual and Inglis, there is no indication that either of these sources combined the steps in any fashion

remotely similar to claim 1. To be sure, anticipation is analyzed on a claim-by-claim basis. But, one seeking to invalidate a patent may not demonstrate invalidity of a claim simply by citing isolated steps in prior art that are not combined in the same fashion as the patent. To the contrary, the Federal Circuit has repeatedly made clear that "[t]o anticipate, every element and limitation of the claimed invention must be found in a single prior art reference, arranged as in the claim." *Brown v. 3M*, 265 F.3d 1349, 1351 [60 USPQ2d 1375] (Fed. Cir. 2001); see also *Karsten Mfg. Corp. v. Cleveland Golf Co.*, 242 F.3d 1376, 1383 [58 USPQ2d 1286] (Fed. Cir. 2001); *Scripps Clinic & Research Foundation v. Genentech, Inc.*, 927 F.2d 1565, 1576 [18 USPQ2d 1001] (Fed. Cir. 1991). [FN 34] Critically, such proof of combination in a single source, arranged as described in the claim, is deficient here.

Accordingly, the court concludes that claim 1 of the '800 patent was neither anticipated by the EPA Manual nor Inglis. None of the dependent claims in the patent, and, particularly, none of the claims that remain valid after this court's application of the on-sale bar, were anticipated by those two references either. Based on this court's resolution of the on-sale issue, this court need not reach defendant's remaining anticipation arguments, which either concern claims of the patent that have already been invalidated or do not reach claims unaffected by the on-sale bar.

c. Obviousness

At the last port of call, this court must determine whether various claims of the '800 patent would have been obvious. To address this assertion, the court must consider anew the Graham factors.

The evidence with respect to three of those factors is readily summarized. Defendant asserts that the relevant prior art includes the '497 patent, the EPA Manual, Inglis, the Keystone plant, U.S. Patent No. 4,834,878 (Anderson), the Nalco Water Handbook (1988), U.S. Patent No. 4,705,640 (Whittaker), U.S. Patent No. 5,213,693 (McGrow et al.), *Sludge Treatment*, (Eckenfelder and Santhanam eds., 1981), and Guy R. Mace, *Specifier's Guide to Polymer Feed Systems*, XXII-5 *Pollution Engineering* 75 (1990). Plaintiff has stipulated that some of these references are analogous prior art and does not seriously contest the characterization of the rest, and, as such, the court finds that the references listed are analogous prior art. [FN 35] For the reasons, and based upon the evidence, summarized above, this court also concludes a person of ordinary skill in the art with respect to the '800

patent would have essentially the same knowledge as one so skilled with respect to the '497 patent. Finally, as was the case with respect to the '497 patent, there is no real objective evidence that sheds any light on the obviousness issue here. Not surprisingly, then, defendant's obviousness allegations rise or fall on a comparison between the '800 patent and prior art.

Turning first to claim 1 of the '800 patent and referring to its expert's reports, defendant asserts on brief that "Mr. Dupon's obviousness analyses of the EPA Manual . . . , the Inglis and Anderson patents . . . , and the Nalco Water Handbook . . . are sufficiently detailed that they need not be repeated here." Examination of the paragraphs of the reports cited by defendant, however, reveals that several of them *1154 do not discuss obviousness at all, but rather anticipation, and refer only to a single prior art reference-- the EPA Manual. In rejecting this anticipation argument above, this court perceived significant differences between the EPA Manual and claim 1 of the '800 patent. Defendant's obviousness arguments based upon the same reference fare no better. What is determinative here, however, is defendant's failure to demonstrate any suggestion or motivation to modify the concepts in the EPA Manual to conform to the elements of claim 1. Thus, in *McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339 [60 USPQ2d 1001] (Fed. Cir. 2001), the Federal Circuit stated, in language that resoundingly resonates here:

In cases such as this where a single prior art reference is alleged to render the claimed invention obvious, there must be a sufficient showing of a suggestion or motivation for any modification of the teaching of that reference necessary to reach the claimed invention in order to support the obviousness conclusion This suggestion or motivation may be derived from the prior art reference itself, from the knowledge of one of ordinary skill in the art, or from the nature of the problem to be solved.

Id. at 1359; see also *SIBIA Neurosciences, Inc. v. Cadus Pharm. Corp.*, 225 F.3d 1349, 1356 [55 USPQ2d 1927] (Fed. Cir. 2000); *B.F. Goodrich Co. v. Aircraft Braking Sys. Corp.*, 72 F.3d 1577, 1582 [37 USPQ2d 1314] (Fed. Cir. 1996). Defendant has failed to provide any evidence on the motivation or suggestion that would have led one skilled in the art to modify the teachings of the EPA Manual to derive claim 1 of the '800 patent. Instead, defendant seemingly suggests that claim 1 is obvious based upon the EPA Manual for the same reason that it is anticipated--and, predictably, for the same reasons

cited above, the court hereby rejects that obviousness assertion, as well. [FN 36]

This court, however, reaches a different conclusion regarding defendant's obviousness arguments based upon the Keystone plant. By definition, all the claims rendered invalid under the on-sale doctrine based on Keystone, which illustrated that those claims were ready for patenting, are also invalid as obvious based upon treating Keystone as prior art. See *Pfaff*, 124 F.3d at 1436 (finding claims obvious based upon what was sold before the critical date); *Baker Oil Tools*, 828 F.3d at 1563. Keystone not only suggests but embodies the teachings in the following claims: 1-5, 18-21 and 23-25. Accordingly, the court finds that all these claims are obvious.

But what of the claims that are not embodied by Keystone? Defendant maintains that these claims are obvious based upon two amalgams: (i) combining all the cited prior art references except for Keystone and Inglis; and (ii) combining the '497 patent with the EPA Manual, Anderson, and Keystone. Remarkably, both arguments proceed without the benefit of any real testimony on what one skilled in the art would have known, and instead, rely exclusively on counsel's assertions regarding these prior art references and, assertedly, the plain language of the references themselves. That one skilled in the art would have combined these references to derive claims such as 8-9, 11-17 or 22 of the '800 patent, however, is far from apparent and certainly cannot be divined from a simple reading of the references, which do not explicitly discuss such combinations. The arguments made by defendant's counsel on brief, which, in some instances, consist little more of string citations to the prior art, do not supply the necessary missing evidentiary link, to wit, clear and convincing evidence that "the prior art would have suggested to one of ordinary skill in the art that this process should be carried out and would have a reasonable likelihood of success, viewed in light of the prior art." *Brown and Williamson Tobacco Corp.*, 229 F.3d at 1124 (quoting *In re Dow Chem.*, 837 F.2d 469, 473 [5 USPQ2d 1529] (Fed. Cir. 1988)). Mere attorney argument is no substitute for concrete evidence of what one skilled in the art would have perceived -- defendant's counsel was neither qualified as an expert nor did he testify at trial, and this court will not permit him essentially to testify in his brief. See *Johnston v. IVAC Corp.*, 885 F.2d 1574, 1581 [12 USPQ2d 1382] (Fed. Cir. 1989) (attorney argument is no substitute for evidence); *In re Budge Mfg. Co.*, 857 F.2d 773, 776 [8 USPQ2d 1259] (Fed. Cir. 1988) (statements of *1155 attorney are "no

evidence"). Indeed, defendant's counsel's *causa patet* assertions that prior art evidences numerous suggestions to combine the '497 patent with these other references ring particularly hollow for several reasons.

First, the new matter introduced by claims 8-9, 11-14 and 16-17 of the '800 patent is not present in any of the prior art references cited by defendant. For example, claim 8 teaches the method of claims 1-2 and 6-7 where, after the addition of the additional flocculating agent polymer, the flocculated metal compound is dewatered in a belt filter press. By comparison, Mace, which of the references cited by defendant most closely approximates this claim, teaches the addition of polymer to primary and secondary clarifiers and discusses the use of a belt filter, but does not mention the addition of additional flocculating agent polymer to the existing floccules prior to their passing through the belt filter. Similarly, unlike claim 11 of the patent, none of the prior art references describes the sequential treatment in clarifier and rotary drum thickener with additional polymers being added during this subprocess. Because critical elements are missing in all the prior art cited by defendant, no level of combination of those references can possibly yield the claims in question. Moreover, defendant has failed to provide any evidence, let alone clear and convincing evidence, that one skilled in the art would have extended the concepts in these references to provide the steps reflected in the subject claims of the patent which are missing in the prior art.

To be sure, the prior art does arguably reference the new matter introduced in claims 15 and 22. In particular, the EPA Manual teaches the use of anionic and cationic polymers for settling purposes in a settling pond. However, as is generally true of all defendant's arguments based upon the EPA Manual, no evidence has been provided that one skilled in the art would have combined the EPA Manual with the '497 patent or any of the other cited prior art references to derive claims 15 and 22. Indeed, the EPA Manual casts doubt on the use of hydroxides as neutralizers, one of the essential steps in claim 1 of the patent, noting that "sludges produced from highly acidic waters neutralized with caustic soda (NaOH) have very low densities and resist compaction despite long storage detention times." Accordingly, it appears that one skilled in the art, upon reading the entire EPA Manual, would have been dissuaded, rather than encouraged, from combining the polymer and settling principles therein with a method for removing metal compounds similar to that described in claim 1. For these reasons and those discussed above, the court concludes that

defendant's assertions regarding claims 8-9, 11-17 and 22 are not well-taken.

A parting observation on this point is warranted. Although its brief professes otherwise, defendant seems to proceed on the notion that as long as it can identify in multiple sources all the elements of a claim, it matters not that there is nothing suggesting some linkage of these elements. But, the law is decidedly to the contrary. [FN37] To be sure, one skilled in the art, closeted in her office, with all the cited prior art conveniently selected and arrayed before her, might have compiled claims equivalent to those in the patent. But, if the case law stresses anything in regards to combination, it is that obviousness is not to be implied simply because all the pieces of a puzzle are present somewhere. Rather, like a real jigsaw puzzle, there must be some suggestion in the art of a complementing association, some teaching providing a guiding framework, or, at very least, some notching or padding of the puzzle pieces themselves, that would lead or incentivize one skilled in the art to derive the combination that is, in the end result, the claim. Here, as in so many of its other obviousness arguments, defendant has paid scant attention to this requirement, treating these all-important linkages almost as if they were self-evident. They are not. Indeed, if this court's jigsaw puzzle analogy goes astray at all, it is in assuming, *arguendo*, that all the pieces of the puzzle, i.e., the elements of the claims, are even present--the foregoing discussion suggests that some pieces are missing and were actually supplied by the inventors here. Thus, *1156 contrary to defendant's importunings, its obviousness argument "is not a perfect puzzle into which all the pieces fit." *Louisiana Public Service Comm. v. F.C.C.*, 476 U.S. 355, 379 (1986).

Accordingly, for the reasons discussed above, the court concludes that defendant has demonstrated that claims 1-5, 18-21 and 23-25 of the '800 patent are obvious. However, defendant has not demonstrated that any of the other claims in the patent are invalid on this basis. [FN38]

IV. CONCLUSION

In an oft-coined phrase, Chief Justice Arthur T. Vanderbilt of the New Jersey Supreme Court once stated that "judicial reform is no sport for the short-winded." [FN 39] The same apparently holds true of patent litigation. Reaching, at long last, the denouement of this lengthy tour d'horizon, the court rejects all but two prongs of defendant's Medusa-like challenge to the validity of the '497 and '800 patents.

Those prongs, however, fatally strike at the heart of the '800 patent, leading this court to invalidate a number of claims therein.

Based upon the foregoing, this court, therefore, concludes:

1. Defendant's arguments regarding the validity of the '497 patent are not well-founded.
2. Claims 1-7, 10, 18-21, 23-25 of the '800 patent are invalid as in violation of the on-sale doctrine of 35 U.S.C. § 102(b).
3. Claims 1-5, 18-21 and 23-25 of the '800 patent are also invalid as obvious under 35 U.S.C. § 103(a).
4. Defendant's other arguments regarding the validity of the '800 patent are not well-founded.

By April 12, 2002, the parties shall file a joint status report indicating how this case should proceed, with a proposed schedule to the extent relevant.

IT IS SO ORDERED.

FN1. A polymer is a macromolecule, a string of organic or inorganic molecules, formed by the chemical union of at least five identical monomers, which are simple molecules or compounds usually made of carbon and exhibiting simple structure and low molecular weight. See Hawley's Condensed Chemical Dictionary 900 (13th ed. 1997). A cationic polymer exhibits a positive ionic charge, while an anionic polymer exhibits a negative ionic charge. *Id.* at 77, 223-24. Polymers aid in flocculation by forcing suspended metal particles to aggregate into clumps or tufts as they pass through a solution containing these long chains of inorganic or organic compounds. *Id.* at 506.

FN2. According to the Patent Act, the specification includes not only the claims of the patent, but also the enablement, written invention description, and best mode. See 35 U.S.C. § 112 (1994); see also *Markman*, 52 F.3d at 979.

FN3. Dictionaries, although a form of extrinsic evidence, may always be relied on by the court to determine the meaning of the claim terms "so long as the dictionary definition does not contradict any definition found in or ascertained by a reading of the patent documents." *Vitronics*, 90 F.3d at 1584 n.6; see also *Interactive Gift Express v. Compuserve, Inc.*, 231 F.3d at 866 n.1; *Kegel Co., Inc. v. AMF Bowling Inc.*, 127 F.3d 1420, 1427 [44 USPQ2d 1123] (Fed. Cir. 1997).

FN4. See *Modine Mfg. Co. v. U.S. Intern. Trade Comm'n*, 75 F.3d 1545, 1554 [37 USPQ2d 1609] (Fed. Cir. 1996) ("Although it is rarely feasible to attach a precise limit to 'about' the usage can usually be understood in light of the technology embodied in the invention."), cert. denied, 518 U.S. 1005 (1996); *W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1557 [220 USPQ 303] (Fed. Cir. 1983) (descriptive term "about," when used to describe ranges in a patent, does not render a claim indefinite), cert. denied, 469 U.S. 851 (1984); *CPC International Inc. v. Archer Daniels Midland Co.*, 831 F. Supp. 1091, 1110 [30 USPQ2d 1427] (D. Del. 1993) ("In the context of determining an appropriate tip speed for a particular vessel and agitator, a person skilled in the art would not find the term 'about 600 cm/sec' to be unclear."), *aff'd*, 31 F.3d 1176 (Fed. Cir. 1994), cert. denied, 513 U.S. 1184 (1995); *Zoltek Corp.*, 48 Fed.Cl. at 300 ("The Court does not agree with Defendant's contention that a precise limit must always be attached to the term 'about.'"); *Syntex (U.S.A.), Inc. v. Paragon Optical Inc.*, 7 U.S.P.Q.2d 1001, 1038 (D. Ariz. 1987) ("'About' is not broad or arbitrary but rather is a flexible term with a meaning similar to 'approximately.'").

FN5. In addition to *Amgen*, defendant relies heavily on this court's decision in *Exxon Research and Engineering Co. v. United States*, 46 Fed.Cl. 278 (2000), which held that a patent which used "words of degree" was invalid. That case, however, was subsequently reversed by the Federal Circuit. See *Exxon Research and Engineering Co.*, 265 F.3d 1371 (Fed. Cir. 2001).

FN6. Thus, at one point during the *Markham* hearing, defendant's expert, Mr. Dupon testified, at some length, regarding the type of bench testing that he would employ to determine the optimal pH for metal precipitation and noted that the amount of testing would depend on the constituent metals in a particular acid mine waste water stream.

FN7. A further word on this feature of "neutralizing supply means" is warranted. As defendant points out, none of the claims of the patent indicate that the apparatus for treating the acidic water is actually portable. However, the specifications to the patent emphasize the portability of the system at two places, indicating that Figure 1 depicts a "portable mine acidic treatment apparatus" and noting that "[t]he unit can be readily transported." The specifications thereby reveal that the structure corresponding to the "neutralizing supply means" must be portable. See *Sofamor Danek Group, Inc. v. DePuy-Motech, Inc.*, 74 F.3d 1216, 1219-1220 [37 USPQ2d 1529] (Fed. Cir. 1996) ("body attaching means" did not include devices with "bulky locking screw," where

specification of patent indicated that the overall apparatus for the patent has "minimum bulk"). Moreover, further resort to the specification discloses several disadvantages of the prior art regarding the treatment of mine drainage, noting, for example, that "known methods involve large machinery which is not easily transportable." To overcome these disadvantages, the preamble to the patent, as well as the summary of the invention, repeatedly emphasizes that the apparatus associated with the patent is portable. In this court's view, these references expressly exclude from the meaning of the "neutralizing supply means" a structure that is not relatively portable. See *Ballard Medical Products v. Allegiance Healthcare Corp.*, 268 F.3d 1352, 1359 [60 USPQ2d 1493] (Fed. Cir. 2001) (noting that statements detailing the shortcomings of relevant prior art are often useful in construing means-plus-function claims); *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1159 [47 USPQ2d 1829] (Fed. Cir. 1998) (holding that a written description did not support claim construction covering conical and non-conical shaped cups where the specification distinguished prior art non-conical shaped cups as inferior and touted the advantages of the conical shape of the patented cup), cert. denied, 122 S.Ct. 580 (2001).

FN8. Indeed, in pressing its view of claim 9 of the patent, the government essentially admitted that the neutralizer employed in the process must be a caustic. See discussion, *infra*, at part III.C.1.v.

FN9. See *Andrew Corp. v. Gabriel Electronics, Inc.*, 847 F.2d 819, 821 [6 USPQ2d 2010] (Fed. Cir. 1988) (holding phrases such as "closely approximate" and "close to" are "ubiquitous in patent claims" and not indefinite when "serving reasonably to describe the claimed subject matter to those of skill in the field of the invention"); *Rosemount, Inc. v. Beckman Instruments, Inc.*, 727 F.2d 1540, 1546-47[221 USPQ 1] (Fed. Cir. 1984) (same conclusion as to words "close proximity"); see also Peter D. Rosenberg, *Patent Law Fundamentals* § 14.06[5][c] (2d ed. 2001).

FN10. Court decisions acknowledge that drawings in the patent may be used to construe claims. 5A Donald S. Chisum, *Chisum on Patents* § 18.03[2][c] [ii] (2001); see also, e.g., *Overhead Door Corp. v. Chamberlain Group, Inc.*, 194 F.3d 1261, 1268 [52 USPQ2d 1321] (Fed. Cir. 1999) ("To interpret the term 'switch' consistently in the claim and to harmonize the drawing depiction with the claim language, this court confirms the district court's reading of the term 'switch.'"); *CVI/Beta Ventures, Inc. v. Tura LP*, 112 F.3d 1146, 1153 [42 USPQ2d 1577] (Fed. Cir. 1997) ("The Claims of the '112 and '955 patents do not define the terms 4% and 3% 'elasticity'. . . In that regard, the patent drawings are highly relevant in construing the elasticity limitations

of the claims.").

FN11. While claim 3 of the '497 patent refers to the aeration process, claim 4 of that patent also claims "[t]he method of claim 3, wherein said primary oxidant source is air." The latter claim suggests that the aeration discussed in claim 3 of the '497 patent could be accomplished using a gas other than air. See *Zoltek*, 48 Fed.Cl. at 293-94 ("When an inventor uses different words or phrases in separate claims, the claims are presumed to have different meanings and scope so that limitations stated in dependent claims are not to be read into the independent claim from which they depend."). The description of the preferred embodiment in the '497 patent, indeed, makes this explicit, indicating:

In addition, the possibility exists that ozone, alone or with different reagents such as hydrogen peroxide, can be combined in the same manner to expand the environment in which this invention may be used. That is, other environments and other types of chemicals for treating various types of pollutants are contemplated as within the scope of the claimed invention.

FN12. There was some debate at trial as to whether one skilled in the art would need to possess particular academic degrees. To be sure, defendant's expert, Mr. Dupon, indicated in his report that certain degrees would be required. However, his testimony at trial clarified that these degrees only were examples of the type of knowledge one skilled in the art would need to possess. Notably, only two of the inventors of the '497 patent (not Mr. Stevenson) possessed these degrees. Accordingly, the court concludes that these formal educational requirements do not represent part of the definition of one who would be viewed as skilled in the art with respect to the '497 patent. See *Penda Corp. v. United States*, 29 Fed.Cl. 533, 565 (Fed. Cl. 1993), appeal dismissed, 44 F.3d 967 [33 USPQ2d 1200] (1994), cert. denied, 514 U.S. 1110 (1995).

FN13. The claims of Inglis provided:

1. In a method of treating industrial waste water from a lead acid battery manufacturing plant contaminated with environmentally unacceptable amounts of sulfuric acid along with lead and copper to lower the concentration thereof to levels permitting discharge of the water to a sewer, the improved steps of:

Adding an amount of an alkaline earth carbonate selected from the group consisting of calcium, magnesium and barium carbonate and mixtures thereof to the waste water to initially raise the pH thereof to a level which is especially conducive to precipitation of

lead and copper carbonate and formation of an alkaline earth sulfate from the sulfuric acid;

The amount of alkaline earth carbonate added to the waste water being sufficient to raise the pH of the waste water to a level of about 4 to about 5 to effect formation of an adequate quantity of alkaline earth sulfate and precipitation of lead and copper carbonate such that upon removal of the precipitates, waste water may be discharged to the sewer which meets environmental restrictions imposed on the discharge;

A mixture of alkaline earth carbonate and alkaline earth hydroxide is added during the second addition and removing lead and copper carbonate precipitates from the waste water prior to discharging the latter to the sewer.

2. In a method of treating industrial waste water as set forth in claim 1, wherein adjusting the pH of the waste water following the addition of the alkaline earth carbonate thereto, to a level above about 7 by addition of an alkaline earth hydroxide before effecting removal of precipitates from the waste water thereby preventing the redissolution of suspended lead and copper carbonates; and the mole ratio of carbonate to hydroxide in the second addition to the waste water is about 1 to 10.

3. In a method of treating industrial waste water as set forth in claim 1, wherein the step of adjusting the pH of the waste water to a value above about 7 with an alkaline earth hydroxide is carried out in a manner to cause the waste water to have a pH of about 8 to 9 prior to discharge of the waste water to the sewer.

FN14. Thus, while the '497 patent anticipated treating up to 500 gallons per minute and the Summitville site was designed and licensed to work at 100 gallons per minute, Mr. Dupon admitted, on cross-examination, that Inglis could be configured only to treat 0.833 gallons per minute.

FN15. Defendant argues that it is irrelevant that Inglis' preferred embodiment is in a batch process as the continuous flow feature is not included in claim 1. However, this contention ignores that part of claim 1 which indicates that the method is designed "simultaneously" to neutralize, oxidize and agitate waste water moving at high flow rates, so as "to reduce reaction time and enhance efficiency of said reaction." As discussed in this part, the specification to the '497 patent indicates that the efficiencies referred to in the claim are produced through the implementation of what one skilled in the art would view as a continuous treatment method. By

comparison, Inglis, which was not primarily designed to deal with mine waste water streams, but rather waste from a lead acid battery plant, does not anticipate rapid reactions and instead relies upon more traditional holding tanks and other means of promoting the eventual settling of contaminants out of the waste water stream.

FN16. Plaintiffs assert that this report was not received in evidence as part of the validity trial, however, the court made clear to the parties that, to avoid repetition, the record in that portion of the case would include the expert reports received at the Markman hearing.

FN17. The arguments made by defendant's post-trial brief concerning claim 6-9 are based, almost exclusively, on observations made by defendant's counsel. Without supporting testimony, the court refuses to consider such observations as being indicative of what one skilled in the art would know. See also discussion *infra* at part III.B.3.c.

FN18. The word "simultaneous" means "happening, existing or done at the same time." See *The American Heritage Dictionary of the English Language* 1623 (4th ed. 2000). The court perceives no reason not to apply the plain meaning of this term in construing this element of claim 5.

FN19. As noted above, defendant also asserts that claims 3-9 are invalid for lack of enablement. Defendant bases this assertion on this court's construction of two elements of claim 3 -- the "means for introducing a source of acidic or metal-bearing water" and the requirement that the "influent pipe means" be "disposed generally adjacent to the discharge end of said aerator shaft." However, defendant failed to produce any testimony whatsoever on this point at the validity hearing, nor did its counsel seek leave to modify this court's pretrial order of October 24, 2000, in this case, which, in listing the issues to be resolved in this stage of the proceedings, raised no enablement issues. The court, accordingly, concludes that defendant waived this assertion. This court, however, would also reject this assertion on the merits because there is nothing about the construction of the "means for introducing a source of acidic or metal-bearing water," which precludes the "influent pipe means" from being generally adjacent to the discharge end of the aerator shaft.

FN20. See *In Re Huang*, 100 F.3d 135, 140 [40 USPQ2d 1685] (Fed. Cir. 1996) (without evidence that the sales are a substantial quantity in the relevant market, "bare sales numbers" are a "weak showing" of commercial success, if any); *In re Baxter Travenol Labs*, 952 F.2d 388, 392 [21 USPQ2d 1281] (Fed. Cir. 1991) ("[I]nformation solely on numbers of units sold

is insufficient to establish commercial success."); *Kansas Jack, Inc. v. Kuhn*, 719 F.2d 1144, 1151 [219 USPQ 857] (Fed. Cir. 1983) ("The evidence of commercial success consisted solely of the number of units sold. There was no evidence of market share, of growth in market share, of replacing earlier units sold by others or of dollar amounts, and no evidence of a nexus between sales and the merits of the invention. Under such circumstances, consideration of the totality of the evidence, including that relating to commercial success, does not require a holding that the invention would have been nonobvious at the time it was made to one skilled in the art.").

FN21. Her letter reads, in pertinent part:

[The PIT System was restarted] on July 27 . . . and [Summitville] directly inject[ed] the . . . polymer in the stream. Only moderate success was achieved with this direct injection method and the quality of the solution in the PITS tanks was not sufficient for discharge. It was evident a near-neutral pH water source would be needed to achieve proper Allied Colloids polymer dosages to the PITS and [Summitville] placed a pump and circulation pipeline in the clear solution (pH 7-8) near the top of the #2 clarifier tank. The Allied Colloids polymer was not compatible with this solution. . . . [Summitville] asked for technical assistance in solving the flocculation and sludge formation problems at the PITS Once . . . a polymer had been found that could be used with the PITS effluent . . . the PITS performed very satisfactorily.

FN22. See generally, Isabelle R. McAndrews, " The On-Sale Bar After *Pfaff v. Wells Electronics: Toward a Bright-Line Rule*," 81 J. Pat. & Trademark Off. Soc'y 155 (1999). The Federal Circuit has repeatedly applied *Pfaff* in its recent cases, noting that the decision supplants the Federal Circuit's prior "totality of the circumstances" analysis of the "on sale doctrine." See *Space Systems/Loral, Inc.*, 271 F.3d at 1079- 80 (citing additional cases); *Vanmoor*, 201 F.3d at 1366; *Brasseler, U.S.A. I, L.P. v. Stryker Sales Corp.*, 182 F.3d 888, 889-90 [51 USPQ2d 1470] (Fed. Cir. 1999); *Weatherchem Corp.*, 163 F.3d at 1333.

FN23. Since this court's decision, the Federal Circuit has clarified somewhat the standard for determining whether a commercial sale or offer of sale of an invention has occurred. Thus, in *Group One, Ltd. v. Hallmark Cards, Inc.*, 254 F.3d 1041, 1048 [44 USPQ2d 1037] (Fed. Cir. 2001), cert. denied, 2002 WL 232913 (2002), the court held that "[o]nly an offer which rises to the level of a commercial offer for sale, one which the other party could make into a binding contract by simple acceptance (assuming

consideration) constitutes an offer for sale under § 102(b)." See also *Linear Technology*, 275 F.3d at 1048. This court's prior finding that there was a commercial sale of the '800 patent invention prior to the critical date is consistent with these decisions.

FN24. Plaintiffs had attempted to counter these facts by alleging that the sale to Summitville was an experimental use. To be sure, a sale of the flocculation method for experimentation rather than profit would not constitute a commercial sale for purposes of applying the first prong of the *Pfaff* test. See *Pfaff*, 525 U.S. 64-65; *Zacharin v. United States*, 43 Fed. Cl. 185, 192 [51 USPQ2d 1493] (1999). However, as observed by this court in its summary judgment ruling:

the Federal Circuit requires solid proof that the sale of an invention be "substantially for purposes of experiment," basing the existence of such a defense on "the objective evidence of experimentation, including the number of prototypes and duration of tests conducted, whether test records and progress reports were kept, the existence of a secrecy agreement, whether the investor received compensation for use of the invention, and the extent to which the inventor controlled the testing."

FN25. This result is dictated by 35 U.S.C. § 282, which provides that "[e]ach claim of a patent (whether independent, dependent, or multiple dependent form) shall be presumed valid independently of the validity of other claims; dependent or multiple dependent claims shall be presumed valid even though dependent upon an invalid claim." See also 35 U.S.C. § 253 ("Whenever without any deceptive intention, a claim of a patent is invalid the remaining claims shall not thereby be rendered invalid."); *Ortho Pharmaceutical Corp. v. Smith*, 959 F.2d 936, 942 [22 USPQ2d 1119] (Fed. Cir. 1992) (citing §§ 282 and 253 and stating "[A] party challenging the validity of a claim, absent a pretrial agreement or stipulation, must submit evidence supporting a conclusion of invalidity of each claim the challenger seeks to destroy." (quoting *Shelcore, Inc. v. Durham Indus., Inc.*, 745 F.2d 621, 625 [223 USPQ 584] (Fed. Cir. 1984))).

FN26. During a March 26, 1998, deposition, taken in conjunction with a separate lawsuit brought by CST against ECC, Mr. Stevenson described the follow-up trips made by CST's employees to the Summitville site, as follows:

Q: Do you recall the nature of the problem was that caused him to go out there and service the equipment?

A: Yes. They knocked it all out of spec and we had

to go set it up for them again.

Q: What do you mean "all out of spec"?

A: They were experimenting with it, I believe, and the pH's weren't proper, the pump speeds weren't proper. They couldn't get the polymers to work.

Q: What did Mr. Knight do to get it back into sync, so to speak?

A: Cleaned check valves, cleaned up the polymer-dosing system, and recalibrated the unit.

Notably, in this deposition testimony, Mr. Stevenson does not mention that he or any other CST representative returned to Summitville to work on the polymer chemistry, so as to allow the method to work on copper.

FN27. These claims provide:

2. The method of claim 1 wherein there is added the further step (f) of further dewatering the floccules separated in step (e).

3. The method of claim 2 wherein additional flocculating agent polymer is added to at least a portion of the waste water containing the flocculated metal compound separated in step e.

4. The method of claim 3 wherein after the addition of the additional flocculating agent polymer, the flocculated metal compound is dewatered in step (f) in a belt filter press.

5. The method of claim 4 wherein there is water which is removed in step (f) and said water removed in step (f) is removed to a polishing pond.

6. The method of claim 2 wherein in step (e) separation is conducted by means of a clarifier.

7. The method of claim 6 wherein additional flocculating agent is added to at least a portion of the flocculated metal compound separated in step (e).

8. The method of claim 7 wherein after the addition of the additional flocculating agent polymer, the flocculated metal compound is dewatered in step (f) in a belt filter press.

9. The method of claim 8 wherein there is water removed in step (f) and said water removed in step (f)

is removed to a polishing means.

10. The method of claim 2 wherein in step (e) separation is conducted by means of sequential treatment in a clarifier and a rotary drum thickener.

11. The method of claim 10 wherein additional flocculating agent polymer is added after the clarifier and then again after the rotary drum thickener.

12. The method of claim 11 wherein after the additional flocculating agent polymer, the flocculated metal compound is dewatered in step (f) in a belt filter press.

13. The method of claim 12 wherein there is water removed in step (f) and said water removed in step (f) is removed to a polishing pond.

14. The method of claim 11 wherein water removed in step (f) is removed to a settling pond.

15. The method of claim 2 wherein step (e) separation is conducted by means of a settling pond.

16. The method of claim 15 wherein additional flocculating agent is added after the settling pond.

17. The method of claim 16 wherein after the additional polymer is added the flocculated metal compound is dewatered in step (f) in a belt filter press.

18. The method of claim 1 wherein in step (a) the pH is adjusted to from about 6 to about 9.

19. The method of claim 1 wherein step (a) the pH is adjusted by adding a neutralizing agent selected from sodium hydroxide, anhydrous ammonia, sulfuric acid and hydrochloric acid.

20. The method of claim 1 wherein the polymer is a cationic polymer which is used for dewatering purposes.

21. The method of claim 1 wherein the polymer is an anionic polymer which is used for primary clarification purposes.

22. The method of claim 1 wherein the polymer is a anionic polymer which is used for settling purposes.

23. The method of claim 1 wherein the polymer is added in a dilute concentration of from about 0.5% to about 1.5% by weight.

24. The method of claim 1 wherein after step (e) a portion of the separated water is removed to a polishing pond.

25. The method of claim 1 wherein in step (e) separation is conducted by means of a rotary drum thickener.

FN28. As noted in the introductory factual summary for this section, plaintiffs rely on a letter sent by Penny McPherson, the environmental manager at the Summitville mine, to various Colorado agencies, describing problems encountered at the site. Plaintiffs assert that this letter shows that the problems identified were fundamental and only solved through Mr. Stevenson's extraordinary efforts. When placed in the context of the entire record, however, Ms. McPherson's letter appears merely to recount the same basic story told by the August 31 report to the Colorado agencies and the other documents in the record. Accordingly, in the court's view, this letter does not support plaintiffs' claims regarding the alleged experimental nature of the Summitville site.

FN29. See also *Enzo Biochem, Inc. v. Calgene, Inc.*, 188 F.3d 1362, 1377 [52 USPQ2d 1129] (Fed. Cir. 1999) ("antisense technology" claim enabled only with respect to some "prokaryotes," but claimed for "eukaryotes" as well, held nonenabled); *In Re Vaeck*, 947 F.2d 488, 496 [20 USPQ2d 1438] (Fed. Cir. 1991) (claim for genetic transformation of "cyanobacteria" held nonenabled where written description enabled invention for only one species of cyanobacteria, not all species).

FN30. An ion, by definition, exhibits a charge, positive or negative. The degree of that charge depends on the disparity, in that ion, between the number of electrons, which carry a negative charge, to the number of protons, which carry a positive charge. In the case of chromium, two ionic valence states predominate--trivalent chromium, which is "missing" three electrons, displays a charge of $\ominus 3$, while hexavalent chromium, which is "missing" six electrons, displays a charge of $\ominus 6$.

FN31. While, at one point in his testimony, Mr. Dupon suggested that one skilled in the art would not consider the use of barium hydroxide, at another point, he indicated only that one skilled in the art would consider the use of calcium hydroxide, sodium hydroxide and potassium hydroxide before considering the use of barium hydroxide. In the court's view, this does not constitute clear and convincing evidence that one skilled in the art would not anticipate the use of barium hydroxide to precipitate chromium as part of the process. The court's finding in this regard is also supported by Dr. Roth, who testified that one skilled in the art would know to use

barium hydroxide to precipitate chromium.

FN32. Thus, the EPA Manual indicates that "[t]he [high-density sludge] process operates successfully only when the lime slurry and recycle sludge are mixed in a reaction tank prior to the addition of acid mine drainage and aeration. This represents the most critical step in the process. Any other process arrangement results in the failure of the process to achieve the desired solids concentration."

FN33. Mr. Dupon's entire testimony, concerning whether the claims of the '800 patent were anticipated and obvious, was as follows:

Q: Mr. Dupon, you gave opinions in your written expert report regarding whether or not the claims of the 800 patent were ready for patenting, anticipated and obvious.

A: Yes, I do.

Q: Interpreting the term--let me give you some assumptions. Assuming that the term, 'removing,' means to take away or eliminate, assuming that the adjustment of pH step means bring the pH to a point that optimizes precipitation -- bring the pH to a point within the range specified that optimizes precipitation of metals, said point to be determined by reasonable experimentation, that aerating means supplying air and other gaseous oxidants to the waste water, and that aerated in said reaction tank means aerated to adequately complete the process of oxidation, on that assumption--on those assumptions, has your opinion regarding the 800 patent and whether it was ready for patenting, anticipated and obvious, changed?

A: No, I do not believe it has.

FN34. Moreover, that court has applied this rule even where, as here, the patent in question employed the inclusive transitional phrase "comprising." See *C.R. Bard, Inc.*, 157 F.3d at 1349.

FN35. As indicated, the list of prior art includes the '497 patent and Keystone. Because the on sale bar applies if "the subject matter of the sale or offer to sell . . . would have rendered the claimed invention obvious by its addition to the prior art," *Pfaff v. Wells Elecs.*, 124 F.3d 1429, 1436 [43 USPQ2d 1928] (Fed. Cir. 1997) (quoting *UMC Elecs. Co. v. United States*, 816 F.2d 647, 657 [2 USPQ2d 1465] (Fed. Cir. 1987)), rev'd on other grounds, 525 U.S. 55 [48 USPQ2d 1641] (1998), what was offered for sale before the critical date becomes, in effect, "a [prior art] reference under section 103 against the claimed invention." *Id.*

at 1436 (quoting *Baker Oil Tools v. Geo Vann, Inc.*, 828 F.2d 1558, 1563 [4 USPQ2d 1210] (Fed. Cir. 1987)); see *Harmon* at 156 ("An inventor's own publication is of course prior art under § 103 if early enough. Thus, where an inventor publishes more than a year before filing, he or she forecloses obtaining a patent on an invention that would have been obvious from the publication, with or without disclosure of other prior art.").

FN36. The same analysis applies to the paragraphs in Mr. Dupon's report asserting that claim 1 of the '800 patent is obvious based solely upon Inglis. Thus, in the absence of any proof that one skilled in the art would have modified Inglis to derive claim 1, the court rejects this assertion for the same reasons it rejected defendant's anticipation argument based on the same reference.

FN37. It bears noting that because these assertions were not made at trial, plaintiffs were not alerted to the possibility that it might need to obtain testimony from Dr. Roth on these points. Indeed, while not determinative herein, there is arguably considerable variation between the issues identified by the parties and incorporated into the pretrial order in this case and some of the assertions made by defendant in its post-trial brief challenging the validity of the patent. In some cases, the additional theories of invalidation were raised for the first time at trial, without objection from plaintiffs; in other instances, this was not true.

FN38. On July 20, 2001, and July 24, 2001, plaintiffs submitted letters to the court regarding U.S. Application Serial No. 09/652,272, which was filed by Mr. Stevenson. The allowed claims of the Application are identical to the claims of the '800 patent, except

that they are limited to the removal of copper, rather than the eight metals listed in the '800 patent. Plaintiffs claim that the significance of the granting of this application is the fact that the prior art raised by defendant in this litigation, including the EPA Manual, the '497 patent and Inglis, were expressly disclosed to the PTO. Plaintiffs assert that, despite these disclosures, the application was granted. They seek to have the court take judicial notice of these facts pursuant to Federal Rule of Evidence 201. Defendant, however, disputes plaintiffs' factual assertions, suggesting that it is unclear what was actually disclosed to the PTO and noting that at least some of the references were not disclosed until shortly before the application was granted. Defendant also observes that this court's constructions of the '497 and '800 patents were not disclosed to the examiner. The court also notes that while the Application was filed March 16, 1999, the court was not previously made aware of its pendency. Based on these circumstances, the court declines to take judicial notice of the circumstances that led up to the granting of the Application and does not rely upon these circumstances, or the granting of the Application itself, in rendering its ruling herein.

FN39. Minimum Standards of Judicial Administration at xix (Arthur T. Vanderbilt ed., The Law Center of New York University for the National Conference of Judicial Councils, 1949).

Fed.Cl.

63 U.S.P.Q.2D 1114

END OF DOCUMENT

Appendix 7:
U.S. Pat. No. 5,041,809 by Payne

[54] GLASS-CERAMIC TEMPERATURE SENSOR FOR HEATING OVENS

[75] Inventors: Thomas R. Payne; John Schultz, both of Louisville, Ky.

[73] Assignee: General Electric Company, Louisville, Ky.

[21] Appl. No.: 462,110

[22] Filed: Jan. 8, 1990

[51] Int. Cl.⁵ H01C 3/04

[52] U.S. Cl. 338/25; 219/505

[58] Field of Search 338/25; 219/494, 504, 219/505, 510; 374/185, 29, 30

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3,006,775	10/1961	Chen	106/39
3,720,900	3/1973	Von Bruning	338/25
3,786,390	1/1974	Kristen	338/22 R
4,050,052	9/1977	Reichelt et al.	338/308
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4,464,646	8/1984	Burger et al.	338/25
4,719,442	1/1988	Bohara et al.	338/25
4,722,609	2/1988	Epstein et al.	338/25 X

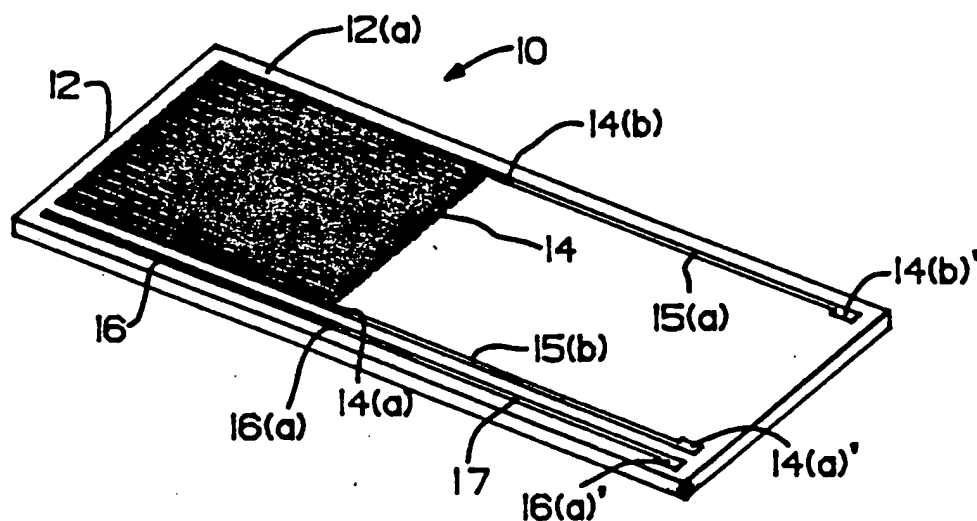
4,791,398 12/1988 Sittler et al. 338/25
4,816,647 3/1989 Payne 219/464

Primary Examiner—Marvin M. Lateef
Attorney, Agent, or Firm—H. Neil Houser; Radford M. Reams

[57] ABSTRACT

A temperature sensor includes a glass-ceramic substrate and a plurality of conductive elements deposited on the substrate. The substrate serves both as a support for the conductive elements and as a temperature-sensitive resistive material forming an operative part of the sensor itself. The conductive elements are arranged to provide one sensor configuration for sensing temperature over a first temperature range as a function of the resistance of one of the elements, a second sensor configuration for sensing temperature over a second temperature range as a function of the surface resistance of the substrate between two of the elements, and a third sensor arrangement for sensing temperature over a third temperature range as a function of the bulk resistance of the substrate between two of the elements separated by a thickness of substrate material less than the surface distance therebetween. Four contact pads are provided to connect the three sensor configurations to external signal processing circuitry.

15 Claims, 4 Drawing Sheets



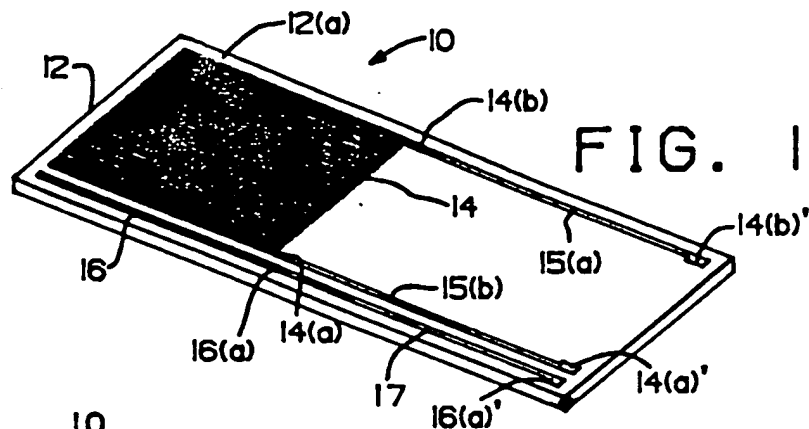


FIG. 1

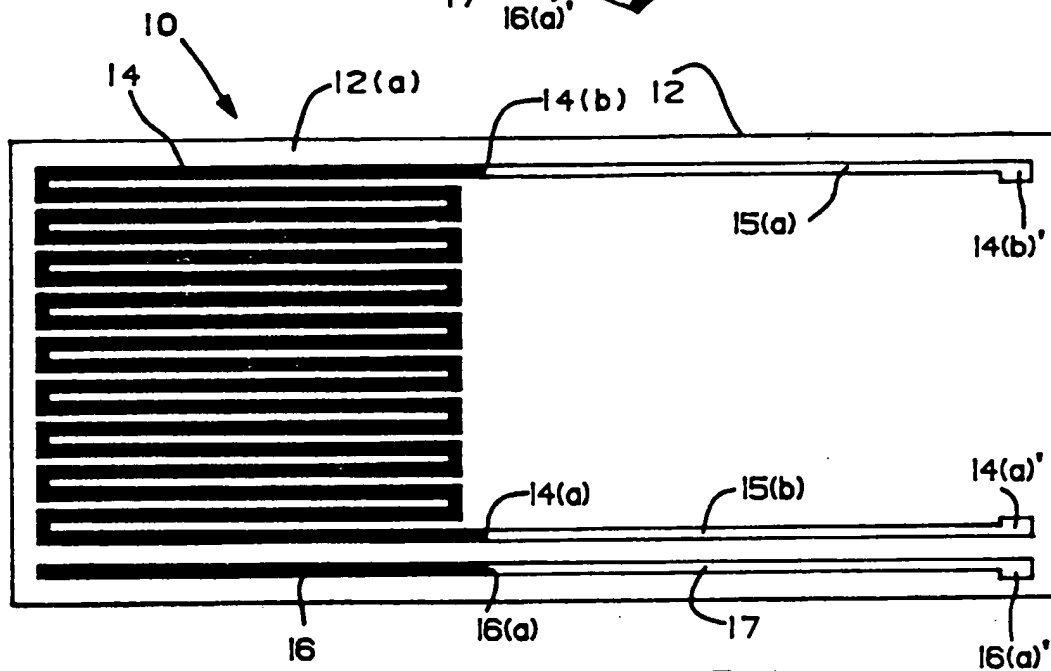


FIG. 2A

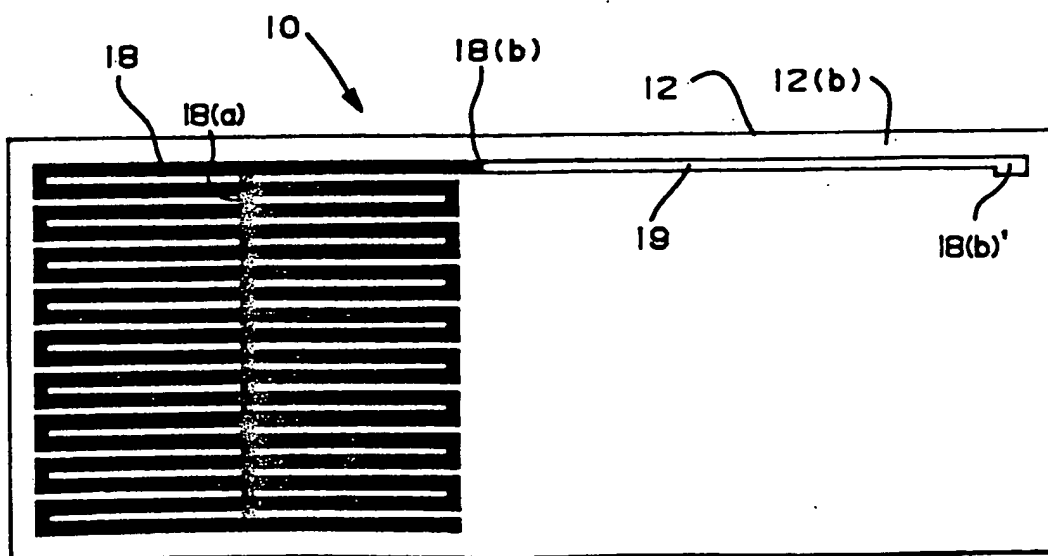


FIG. 2B

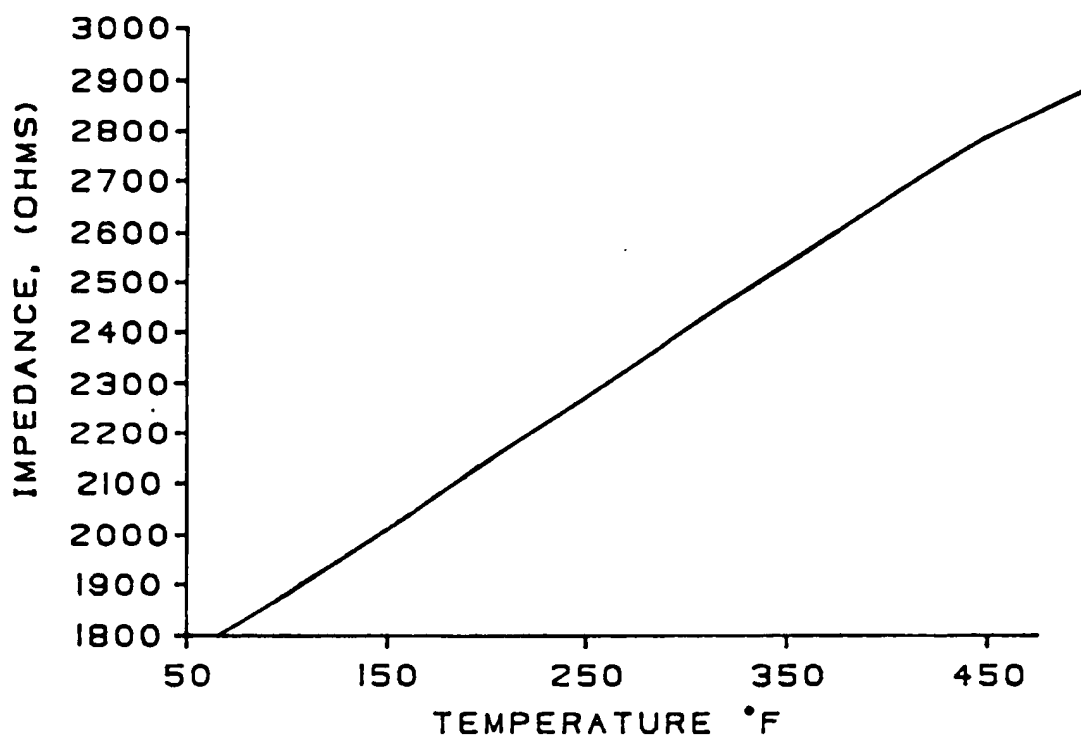


FIG. 3

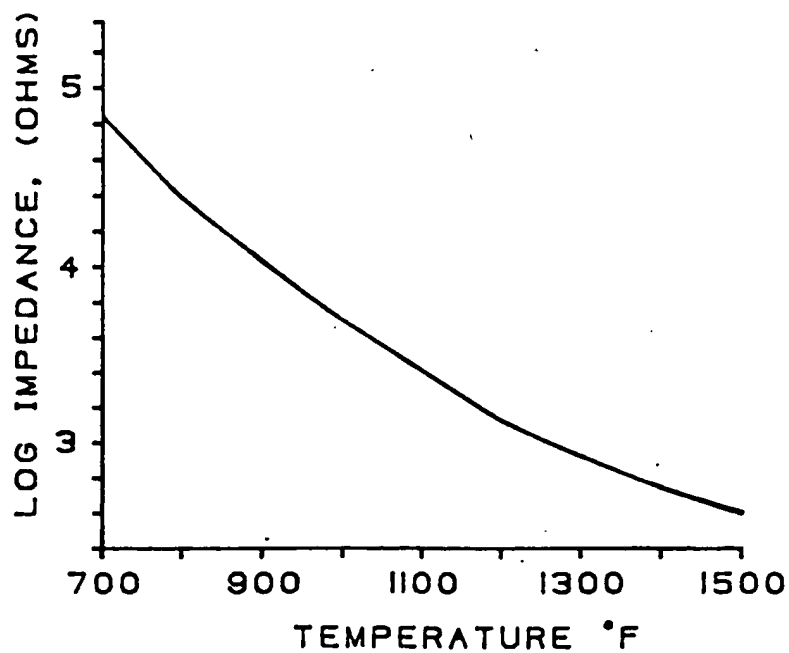


FIG. 4

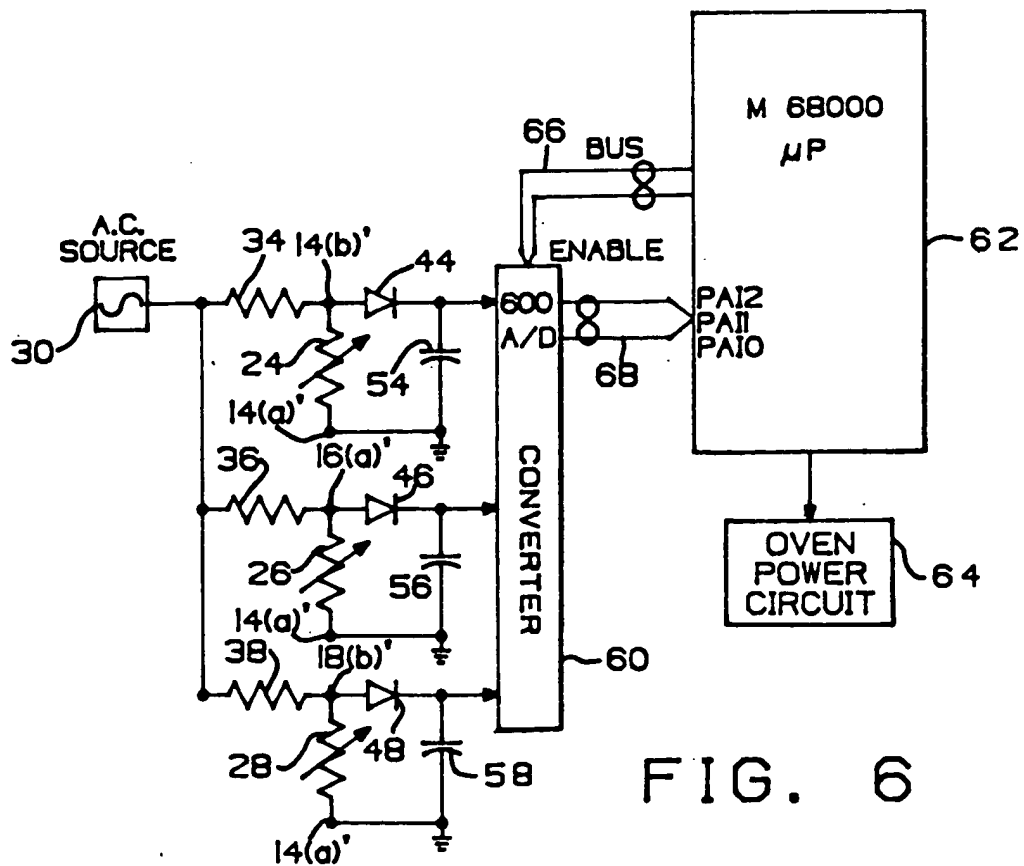
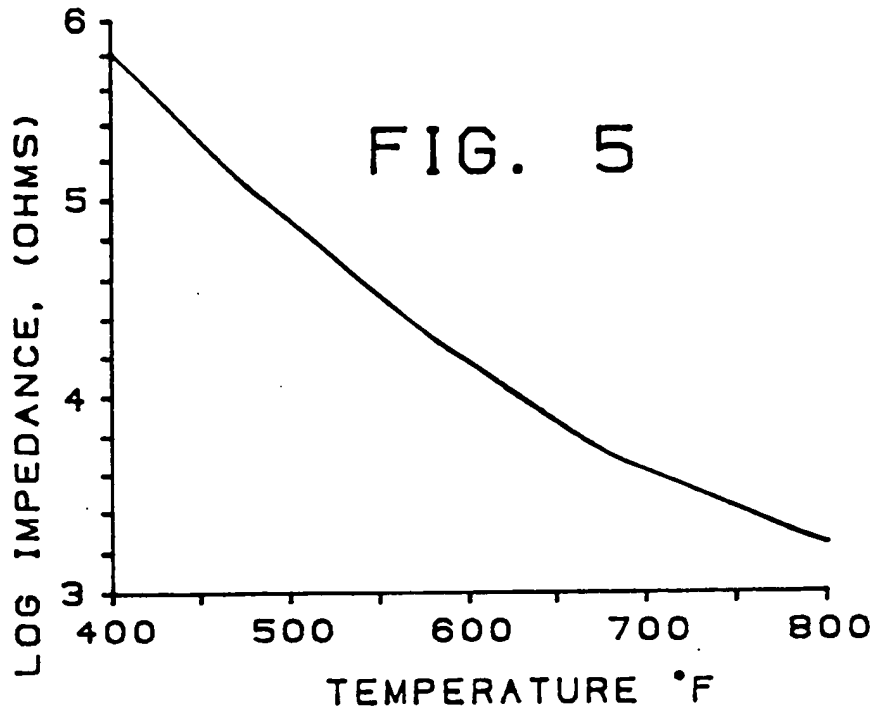
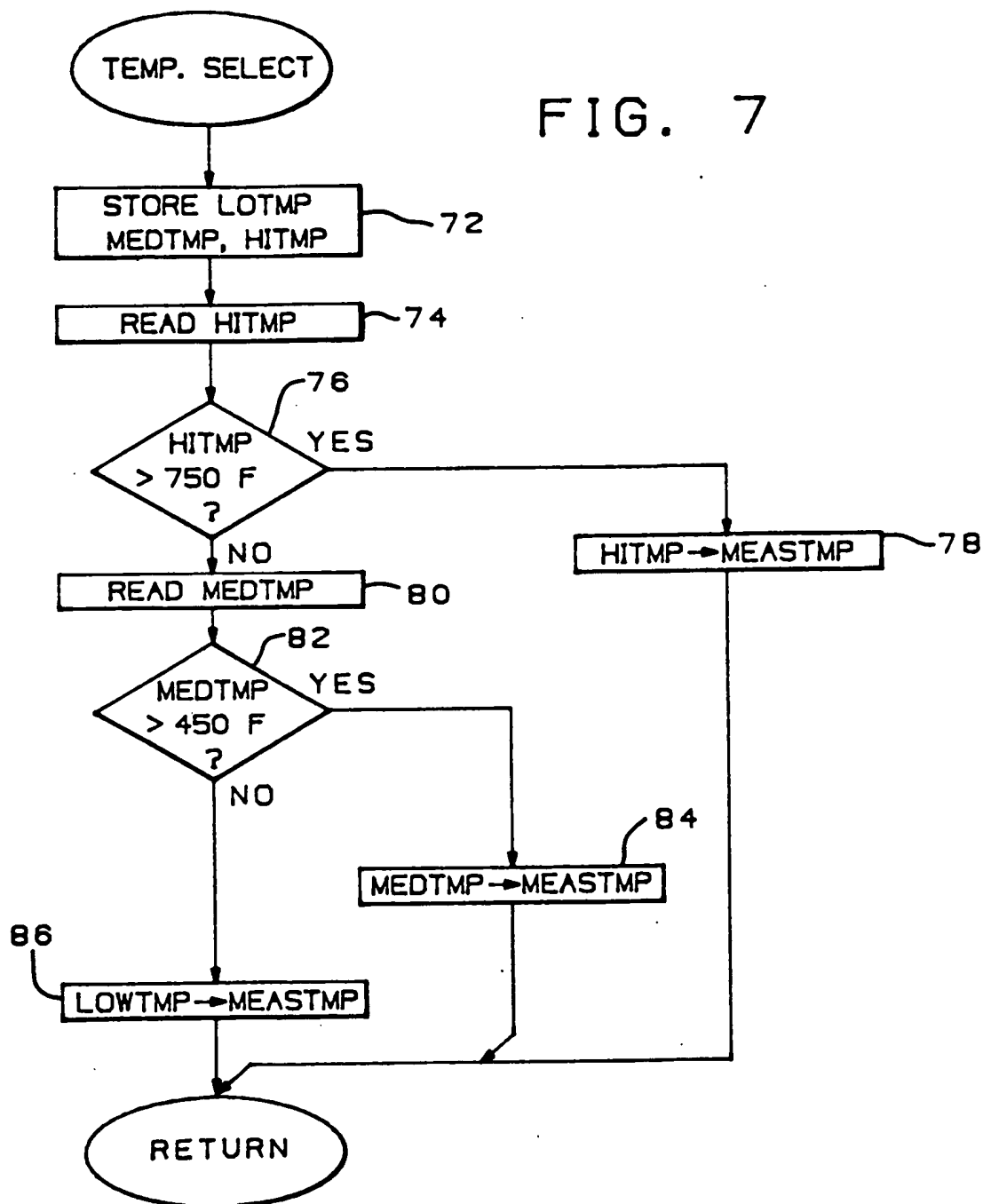


FIG. 7



GLASS-CERAMIC TEMPERATURE SENSOR FOR HEATING OVENS

BACKGROUND OF THE INVENTION

This invention relates generally to temperature sensors of a type having application to heating ovens, and is particularly advantageously employed as a temperature sensor in domestic self-cleaning cooking ovens.

In self-cleaning domestic cooking ovens it is desirable to be able to control the oven temperature over an operating range on the order of 100° F. to 1000° F. or higher. In commercially available domestic thermal cooking ovens with electronic control systems, the temperature sensor typically comprises a sheathed length of nickel or nickel alloy wire which extends into the oven cavity along the rear interior wall. Temperature measurements are derived as a function of the resistance of the wire which changes with temperature. Such wire sensors are characterized by a relatively low temperature coefficient of resistivity. Thus, while the sensor itself is relatively inexpensive, the associated circuitry required to accurately detect relatively small changes in temperature for the range of operating temperatures over which the control system must operate is relatively costly.

Platinum resistance temperature detectors (RTD) of various types are also commercially available for measuring temperatures in the range of interest for self-cleaning oven applications. However, in addition to being relatively costly, RTD's have the same disadvantages as the nickel wire sensors, low temperature coefficient of resistivity over the temperature range of interest.

In commonly assigned U.S. Pat. No. 4,816,647 to Payne, a radiant cooktop appliance with a glass-ceramic cooktop surface includes a sensor for monitoring the temperature of the cooktop comprising a pair of parallel conductive strips deposited on the underside of the glass-ceramic surface. The surface resistance of the glass between the strips provides a measure of the temperature of the cooktop surface in that region. One disadvantage of such a sensor arrangement is its extremely high resistivity toward the lower end of the temperature range of interest for self-cleaning ovens, necessitating the use of additional circuitry to measure the temperature with sufficient accuracy over the entire operating range.

U.S. Pat. No. 3,786,390 to Kristen discloses a temperature sensor which senses temperature as a function of the bulk resistance of a glass-ceramic material between the conductive leads. However, it too is characterized by extremely high resistivity in the lower portion of the temperature range of interest.

Resistance thermometers employing a sensor structure comprising conductive film deposited on a glass substrate in a serpentine pattern to sense temperature as a function of the resistance of the conductive film itself is disclosed in U.S. Pat. No. 3,720,900. This sensor arrangement for use in precision scientific instruments to measure temperatures ranging from room temperature down to very low temperatures on the order of 10° K. In this arrangement the glass merely serves to structurally support the conductive film. While such an arrangement might work well at the very low end of the cooking temperature range, it would likely not be satisfactory in the higher temperature and in any event such

precision devices are too costly for domestic appliance applications.

Therefore, a need exists for a relatively inexpensive temperature sensor for electronically controlled domestic self-cleaning cooking ovens which provides better accuracy over the entire operating range than that achievable with conventional nickel wire sensors without need for the relatively expensive signal processing circuitry.

It is therefore an object of the present invention to provide a temperature sensor comprising relatively inexpensive materials, which is easily and inexpensively assembled and which operates over the range of 100° F. to 1500° F. with resistance values sufficiently low over this range to permit improved accuracy without need for complex and costly interface circuitry to process the temperature signals derived from the sensor.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention a temperature sensor comprises a glass-ceramic substrate and a plurality of conductive elements deposited on or in the substrate. The substrate serves both as a support for the conductive elements and as a temperature-sensitive resistive material comprising an operative part of the sensor itself. The conductive elements are arranged to provide a first sensor configuration for sensing temperature over a first temperature range as a function of the resistance of one of the elements, a second sensor configuration for sensing temperature over a second temperature range as a function of the surface resistance of the substrate between two of the elements, and a third sensor arrangement for sensing temperature over a third temperature range as a function of the bulk resistance of the substrate between two of the elements separated by a thickness of substrate material less than the surface distance therebetween. Four contact pads are provided to connect the three sensor configurations to external signal processing circuitry.

In a preferred form of the invention the substrate is a generally planar piece of glass-ceramic material. The first sensing arrangement comprises a first conductive element in the form of a thin conductive film deposited on the upper surface of the substrate in a serpentine pattern with contact pads for connection to external circuitry at each end thereof. Temperature is sensed over a relatively low temperature range as a function of the resistance of the conductive strip between the two pads. The second sensing arrangement comprises a second conductive element in the form of a strip of conductive film deposited on the upper surface uniformly laterally spaced from a peripheral portion of the first element with a contact pad for connecting this strip to external circuitry. Temperature is measured by this configuration over the relatively high portion of the operating range for the sensor as a function of the surface resistance of the substrate between the first and second conductive elements. The third sensor configuration comprises a third conductive element deposited on the lower surface of the substrate generally opposite and in a pattern generally similar to the first conductive element, with a contact pad for connection to external circuitry. Temperature information is derived from this configuration over the temperature range intermediate the low and high ranges as a function of the bulk resistance of the ceramic material between the first and third conductive elements.

In accordance with another aspect of the invention a plurality of conductive elements is deposited on or in a glass-ceramic substrate so as to provide two sensor configurations for measuring temperature over an operating range divided into a relatively higher portion and a relatively lower portion. The first sensor configuration comprises first and second laterally spaced elements deposited on the upper surface of the substrate for sensing temperature over the relatively high portion of the operating range as a function of the surface resistance of the substrate between the first and second conductive elements. The second sensor configuration comprises a third conductive element deposited on the lower surface of the substrate generally opposite and in a pattern which generally underlies one of the first and second elements, for sensing temperature as a function of the bulk resistance of the ceramic material between the third element and that one of the first or second elements which it underlies.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a temperature sensor illustratively embodying the present invention enlarged to more clearly illustrate structural details;

FIGS. 2A and 2B are elevational top and bottom views respectively of the sensor of FIG. 1;

FIG. 3 is a graphical representation of the relationship of resistance and temperature for the low temperature sensor configuration for the sensor of FIG. 1;

FIG. 4 is a graphical representation of the relationship of resistance and temperature for the high temperature sensor configuration for the sensor of FIG. 1;

FIG. 5 is a graphical representation of the relationship of resistance and temperature for the intermediate temperature sensor configuration for the sensor of FIG. 1;

FIG. 6 is a simplified schematic circuit diagram for an oven control circuit incorporating the sensor of FIG. 1; and

FIG. 7 is a flow diagram of the Temp Select routine incorporated in the control program for the microprocessor in the circuit of FIG. 6.

DETAILED DESCRIPTION

Referring now to FIGS. 1, 2A and 2B, a temperature sensor illustratively embodying the present invention, designated generally 10, comprises a generally planar glass-ceramic substrate 12 having a first or upper surface 12(a) and a second or lower surface 12(b), and a plurality of conductive strips 14, 16 and 18. Strips 14 and 16 are deposited on surface 12(a) with strip 18 deposited on surface 12(b), generally opposite and laterally co-extensive with strip 14.

The term "glass-ceramic" as used herein refers primarily to a re-crystallized silicate material characterized by virtually zero thermal expansion and a high thermal coefficient of resistivity such as the Ceran family of materials manufactured by Schott Glaswerke and similar materials manufactured by Nippon Electric Glass Company and Corning Corporation, but is intended to also include any other silicate materials including so-called "doped glass" having comparable thermal coefficients of resistivity characteristics. Substrate 12 is formed of a lithium aluminum silicate material designated Ceran-85 manufactured by Schott Glaswerke. This particular material has been found to provide satisfactory performance as the substrate for a sensor over the temperature range of interest for domes-

tic self-cleaning ovens. However, it should be appreciated that other conductive glass and glass-ceramic compositions may be similarly employed.

Conductive strip 14 is disposed over the upper surface 12(a) of substrate 12 in a serpentine pattern which terminates at contact points 14(a) and 14(b) formed at opposite ends thereof. Strip 14 is preferably approximately 0.05 inches wide, and 35 inches long with a nominal thickness of 10000Å. Each length of strip 14 is laterally separated by approximately 0.05 inches. Use of a serpentine pattern for strip 14 provides the necessary strip length in a limited surface area. Conductive strip 16 is of comparable width and thickness to strip 14, extending parallel to that portion of strip 14 which terminates in pad 14(b). Strip 16 is separated from this closest portion of strip 14 by approximately 0.3 inches. Conductive strip 18 is applied to the surface 12(b) opposite conductive strip 14 in an open pattern similar to the serpentine pattern of strip 14 with the addition of a central shorting strip 18(a) extending the width of the pattern perpendicular to the long legs of the pattern to better approximate the electrical conductivity of a solid square or rectangular pattern. The open pattern is preferred for strip 18 primarily because it requires less conductive material than a solid pattern over the same area. However, the particular configuration of strip 18 is not critical provided it substantially underlies, i.e. is laterally coextensive with strip 14. For example, it could be a solid pattern having a perimeter comparable to the peripheral dimensions of the serpentine pattern of strip 14. Strip 18 has a single contact point 18(b). Conductive runs 15(a) and 15(b), 17 and 19 electrically connect contact points 14(a), 14(b), 16(a) and 18(b) to terminal pads 14(a)', 14(b)', 16(a)' and 18(b)', respectively, located at the opposite end of substrate 12.

Electrical connection of the sensor strips 14, 16, and 18 to external control circuitry is complicated by the high temperature environment presented inside an oven cavity. Soldering is a preferred method of connection for ease of manufacturing and reliability. However soldered connections must be protected from the internal oven temperatures. Substrate 12 is elongated to facilitate a mounting arrangement in which the sensor may be mounted in a slot in the rear wall of the oven with the sensor strips 14, 16 and 18 located inside the oven and the terminal pads located outside the oven. When mounted in this way, the terminal pads are not exposed to the high temperatures inside the oven and may be connected to external control circuitry by conventional soldering techniques.

For the oven sensor of the illustrative embodiment substrate 12 measures approximately 2.7"×5.4"×0.125". It will be appreciated, however, that other dimensions and substrate configurations could be similarly employed.

Conductive strips 14, 16 and 18 may be deposited on substrate 12 by conventionally screen printing a metal-organic paste commonly referred to as a resinate on the glass-ceramic surface in the desired pattern using for example a 200 mesh screen. In the illustrative embodiment a platinum paste designated A4649 available from Engelhard Corporation is used for the conductive strips; however, other metal combinations could also be used, provided the material used for strip 14 provides a suitable thermal coefficient of resistivity to allow strip 14 to function as a temperature sensor as hereinafter described. Conductive runs 15(a), 15(b), 17 and 19 may be similarly deposited on substrate 12. However in

order to prevent these conductive runs from adversely affecting sensor performance, they should be fabricated of a very highly conductive material such as a palladium silver paste, designated A-2519 available from Engelhard Corporation.

In accordance with one form of the present invention particularly applicable to a self-cleaning oven temperature control system, conductive strips 14, 16 and 18 are cooperatively configured in combination with substrate 12 to provide a temperature sensor 10 which includes three sensor configurations. Each configuration is most effective relative to the others over a different portion of the operating temperature range. The external control circuitry can selectively use the temperature information from that one of the three configurations associated with the temperature range containing the temperature then being sensed.

The first sensor configuration comprises strip 14. In this configuration the resistance of strip 14 between pads 14(a)' and 14(b)' is measured to obtain temperature information. Glass substrate 12 merely serves as a support structure for conductive strip 14. The resistance versus temperature curve for strip 14 is shown in FIG. 3. This sensor works particularly well for temperatures in the 100°-450° F. temperature range. Though the resistance for this sensor increases approximately 2.6 ohms per °F., which is considerably lower than that of the glass-ceramic substrate, it provides absolute resistance values in the range of 1900-2800 ohms over the lower portion (100°-450°-F.) of the sensor operating range. By contrast the glass-ceramic substrate resistance is greater than 10⁶ ohms toward the lower end of this same range.

A second sensor configuration uses strip 14 in combination with strip 16 and substrate 12 to provide temperature information as a function of the resistance of glass-ceramic substrate 12 between strips 14 and 16, which is essentially the surface resistance of the glass-ceramic material. The temperature vs resistance characteristics for this sensor configuration is illustrated in FIG. 4. As shown in FIG. 4, this configuration is best suited for use in the relatively high temperature range of 750°-1500° F. Over this range the resistance varies from a high of about 50,000 ohms down to about 300 ohms. At temperatures below about 750° F. the resistance varies from 10³ to the undesirably high value of 10¹² ohms.

A third sensor configuration comprising the combination of strips 14 and 18 and glass-ceramic substrate 12 measures the temperature in the range generally between the aforementioned low and high temperature ranges (i.e. 450° F.-750° F.). This combination provides temperature information as a function of the bulk resistance of the substrate, i.e. the resistance presented by the thickness of the glass-ceramic material between strips 14 and 18. The resistance vs. temperature characteristic of the glass-ceramic substrate between strips 14 and 18 is illustrated in FIG. 5, which shows that the resistance of glass-ceramic substrate 12 between strips 14 and 18 varies from a high of about 200,000 ohms at 450° F. to a low of about 2000 ohms at about 750° F.

Thus, by this arrangement sensor 10 can be used to measure temperature over the range of 100° F. to 1500° F. with an effective sensor resistance confined to range of approximately 300 ohms to 200,000 ohms, a resistance range which can be used without the added cost of interface circuitry which would be required for the wider range of resistance values which would be re-

quired for sensors relying solely on a single ceramic sensor configuration.

By employing contact terminal pad 14(a)' as the common ground pad for all three sensor configurations, sensor 10 can be connected to the external control circuitry, using only four leads, one connected to each of pads 14(a)', 14(b)', 16(a)' and 18(b)'.

Illustrative external control circuitry for controlling the temperature in a domestic cooking oven incorporating sensor 10 is schematically illustrated in FIG. 6. Each of the three sensor configurations is represented in the circuit of FIG. 6, as a variable resistor. Resistor 24 represents the low temperature configuration comprising the resistance of strip 14 between pads 14(a)' and 14(b)'. Resistor 26 represents the high temperature configuration comprising the resistance between strips 14 and 16, as measured between pads 14(a)' and 16(a)'. Resistor 28 represents the intermediate temperature configuration comprising the resistance between strips 14 and 18 as measured between pads 14(a)' and 18(b)'.

An AC drive is necessary for the sensor configurations which use the resistance of the glass to prevent polarization of the glass which would eventually occur if the dc source were to be applied. The drive circuit for each of the sensor configurations comprises a 5 volt, 60 Hz, AC supply 30 which is coupled to resistances 24, 26 and 28 via 2K ohm

34, 36 and 38 respectively, at terminal pads 14(b)', 16(a)' and 18(b)' respectively. Diodes 44, 46 and 48 and 10 uf capacitors 54, 56 and 58 respectively rectify and smooth the AC signal appearing at terminal pads 14(b)', 16(a)' and 18(b)' for input to A/D converter 60. Converter 60 is a Motorola 600 A/D converter circuit.

Converter circuit 60 converts the analog voltage signals to digital signals for input to microprocessor 62, which generates power control signals for oven power circuit 64 as a function of the sensed temperature. Microprocessor 62 is a Motorola 68000 series microprocessor programmed to operate as a virtual memory machine, with its read only memory (ROM) permanently configured to implement a power control scheme for a range oven which uses temperature information from sensor 10, to control oven temperature.

Microprocessor 62 sequentially enables the input from each sensor configuration by enable signals coupled to converter 60 via bus 66. The converted output for the enabled sensor is then coupled by bus 68 to microprocessor 62 for storage at the corresponding one of the three memory locations PAI0, PAI1 and PAI2 for resistances 24, 26 and 28 respectively. By this arrangement the temperature sensed by each configuration is periodically stored in the microprocessor memory.

It will be recalled that microprocessor 62 is customized by permanently configuring the ROM to implement a predetermined set of instructions to control oven temperature as a function of temperature information from sensor 10. FIG. 7 illustrates a flow diagram for the Temp Select control routine which enables the microprocessor to read in and store the sensor input signals and select the particular one of the three stored values to be used for the next power control decision. From this diagram one of ordinary skill in the programming art could prepare a set of instructions for permanent storage in the ROM of microprocessor 62 which would enable the microprocessor to implement this routine. It will be appreciated that other sub-routines would be included to perform the actual power control functions

for the oven as well as other control functions for the appliance.

The function of the Temp Select routine is to select the temperature input obtained from the appropriate one of the three sensor configurations according to the temperature then being sensed. This is accomplished by first looking at the input from the high temperature configuration. If this input represents a temperature greater than 750° F., it is used as the power control value. If not, the input from the intermediate range configuration is checked. If the temperature is greater than 450° F., this value is used as the control value. If less than 450° F., the value from the low temperature configuration is used.

Referring now to FIG. 7, on entering this routine the program stores the signals sequentially received via bus 68 at memory locations PAI0, PAI1 and PAI2. The information stored at these locations is identified respectively as variables HITMP, MEDTMP and LOTMP (Block 72). The signal stored at PAI0 corresponding to the output from the high temperature sensor configuration designated HITMP is read first (Block 74). If the sensed temperature is greater than 750° F. (Yes at Inquiry 76) this value is stored as the variable MEASTMP (Block 78), the variable used to represent the sensed oven temperature in the power control routine (not shown). Returning to Inquiry 76, if the output from the high temperature sensor configuration is less than 750° F., the output stored at PAI1 representing the output from the intermediate temperature sensing configuration represented by the variable MEDTMP is read (Block 80) and compared to 450° F. (Inquiry 82). If greater, MEDTMP is stored as MEASTMP (Block 84); if less, the output from the low temperature sensor configuration stored at PAI2 is stored as the operative temperature variable MEASTMP (Block 86).

The above described sensor is particularly useful in applications such as self-cleaning domestic ranges in which the temperature range of interest is so broad as to require all three sensor configurations. However, sensors in accordance with the present invention are not limited to cooking ovens. Such sensors may find application with industrial ovens as well. In applications in which the temperature range of interest is broader than the range covered by a single sensor configuration, but not so broad as to require three sensors, sufficient accuracy may be achieved using a two sensor configuration which utilizes only the resistance of the substrate material. For example, industrial ovens might require precise control over the range of 500° F. to 1500° F. In such applications the operating range may be conveniently divided into two portions, a high temperature portion and a low temperature portion. The configuration of such a sensor could be as illustrated in FIGS. 1, 2A, and 2B with the exception that only a single terminal pad 14(a)' and lead 15(a) would be needed for strip 14. In addition strip 14 need not be serpentine in configuration but could be a square filled in completely with conductive film or could be essentially identical to the open pattern of conductive element 18.

The control system for the two sensor configuration could be substantially the same as that shown schematically in FIG. 6, except that circuit elements for the sensor configuration using the resistance of strip 14, namely, variable resistor 24, current limiting resistor 34, diode 44 and capacitor 54, would not be needed. The control routine of FIG. 7 could be simplified to separately store only the inputs from the high temperature

sensor configuration and the low temperature configuration. The high temperature input could be compared to a reference representative of the dividing temperature that is, the temperature at the boundary between the high and low temperature portions of the operating temperature range. If the high temperature input is higher than the reference it is used as the operative input temperature for power control purposes. If not, the low temperature input is used as the operative input temperature.

While in accordance with the Patent Statutes specific embodiments of the present invention have been illustrated and described herein, it is realized that numerous modifications and changes will occur to those skilled in the art. For example, the embodiments herein described are primarily intended for use as temperature sensors in self-cleaning domestic ranges. However, it will be appreciated that such sensors could be adapted for use in a variety of other applications such as industrial ovens with materials, dimensions and conductive strip configurations selected to optimize performance and cost for particular applications. It is therefore to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit and scope of the invention.

What is claimed is:

1. A temperature sensor comprising:

a generally planar glass-ceramic substrate;

first sensing means for sensing temperature over a first temperature range comprising a first conductive element deposited on one surface of said substrate;

second sensing means for sensing temperature over a second temperature range comprising said first element and a second conductive element deposited on said one surface of said substrate adjacent and laterally spaced from a portion of said first element; and

third sensing means for sensing temperature over a third temperature range comprising said first element and a third conductive element deposited on the opposite surface of said substrate generally laterally coextensive with said first element.

2. A temperature sensor in accordance with claim 1 wherein said first conductive element comprises a conductive film deposited on said one side of said substrate in a generally serpentine pattern and including a contact pad formed at each end thereof for connection to external circuitry and wherein said first sensing means is adapted to provide temperature information as a function of the electrical resistance of said first element between said contact pads.

3. A temperature sensor in accordance with claim 2 wherein said second conductive element comprises a conductive film including a conductive pad formed at one end thereof for connection to external circuitry and wherein said second sensing means is adapted to provide temperature information as a function of the electrical resistance of said glass substrate proximate said first surface thereof between said first and second elements.

4. A temperature sensor in accordance with claim 3 wherein said third conductive element comprises a conductive film including a contact pad for connection to external circuitry and said third sensing means is adapted to provide temperature information as a function of the electrical resistance of said glass substrate between said first and third elements.

5. A temperature sensor in accordance with claim 4 wherein said first temperature range is a relatively low range, said second temperature range is a relatively high range, and said third temperature range is between said first and second ranges.

6. A temperature sensor comprising:

a generally planar glass-ceramic substrate;

a first conductive element deposited on one surface of said substrate for sensing temperature over a first temperature range as a function of the electrical resistance of said first conductive element;

a second conductive element deposited on said one surface of said substrate adjacent, laterally spaced from a portion of said first element and operative in combination with said first element and said substrate for sensing temperature over a second temperature range as a function of the electrical resistance of said substrate between said first and second elements; and

a third conductive element deposited on the opposite surface of said substrate generally underlying said first element and operative in combination with said first element and said substrate for sensing temperature over a third temperature range as a function of the electrical resistance of said substrate between said first and third elements.

7. A temperature sensor in accordance with claim 6 wherein said first temperature range is a relatively low range, said second temperature range is a relatively high range and said third temperature range is intermediate said first and second ranges.

8. A temperature sensor in accordance with claim 6 wherein said second and third elements each include a single contact pad and said first element includes a pair of contact pads, one at each end thereof, one of said pair comprising a common pad utilized over all three of said temperature ranges.

9. A temperature sensor comprising:

a glass-ceramic substrate and a plurality of conductive elements deposited on said substrate, said conductive elements being arranged to provide a first sensing means for sensing temperature over a first temperature range as a function of the electrical resistance of one of said elements, a second sensing means for sensing temperature over a second temperature range as a function of the surface electrical resistance of said substrate between two of said elements and a third sensing means for sensing temperature over a third temperature range as a function of the bulk electrical resistance of said substrate between two of said elements separated from each other by a thickness of said substrate less than the surface distance therebetween.

10. A temperature sensor in accordance with claim 9 wherein said one element of said first sensing means comprises one of said two elements in said second sensing means and one of said two elements of said third sensing means.

11. A temperature sensor comprising:

a glass-ceramic substrate and a plurality of conductive elements deposited on said substrate, said conductive elements being arranged to provide a first sensing means for sensing temperature over a first

relatively high temperature range as a function of the surface electrical resistance of said substrate between two of said elements and a second sensing means for sensing temperature over a second temperature range as a function of the bulk electrical resistance of said substrate between two of said elements separated from each other by a thickness of said substrate less than the surface distance therebetween.

12. A temperature sensor for sensing temperature over an operating temperature range divided into an upper portion and a lower portion, said sensor comprising:

a generally planar glass-ceramic substrate;

first sensing means for sensing temperature over the upper portion of the operating temperature range comprising first and second conductive elements deposited on one surface of said substrate adjacent and laterally spaced from each other; and

second sensing means for sensing temperature over the lower portion of the operating temperature range comprising one of said first and second elements and a third conductive element deposited on the opposite surface of said substrate generally laterally coextensive with said one of said first and second elements.

13. A temperature sensor in accordance with claim 12 wherein said first and second conductive elements each comprise a conductive film including a conductive pad formed at one end thereof for connection to external circuitry and wherein said first sensing means is adapted to provide temperature information as a function of the electrical resistance of said glass substrate proximate said first surface thereof between said first and second elements.

14. A temperature sensor in accordance with claim 13 wherein said third conductive element comprises a conductive film including a contact pad for connection to external circuitry and said second sensing means is adapted to provide temperature information as a function of the bulk electrical resistance presented by the thickness of said glass-ceramic substrate between said third element and said one of said first and second elements.

15. A temperature sensor comprising:

a generally planar glass-ceramic substrate;

first and second conductive elements deposited on one surface of said substrate adjacent and laterally spaced from each other and operative in combination with said substrate for sensing temperature over a first temperature range as a function of the surface electrical resistance of said substrate between said first and second elements; and

a third conductive element deposited on the opposite surface of said substrate generally underlying one of said first and second elements and operative in combination with said one of said first and second elements and said substrate for sensing temperature over a second temperature range as a function of the bulk resistance of the thickness of said substrate between said third element and said one of said first and second elements.

* * * * *

Appendix 8:
U.S. Pat. No. 4,767,586 by Radwanski

United States Patent [19]

Radwanski et al.

[11] Patent Number: 4,767,586

[45] Date of Patent: Aug. 30, 1988

[54] APPARATUS AND METHOD FOR FORMING A MULTICOMPONENT INTEGRAL LAID FIBROUS WEB WITH DISCRETE HOMOGENEOUS COMPOSITIONAL ZONES, AND FIBROUS WEB PRODUCED THEREBY

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[73] Assignee: Kimberly-Clark Corporation, Neenah, Wis.

[21] Appl. No.: 818,440

[22] Filed: Jan. 13, 1986

[51] Int. Cl.⁴ D04H 1/04

[52] U.S. Cl. 264/113; 264/112; 264/115; 264/121; 264/518; 425/81.1; 425/82.1; 425/83.1

[58] Field of Search 264/517, 518, 121, 122, 264/115, 116, 112, 113; 425/81.1, 82.1, 83.1; 428/284, 296, 420

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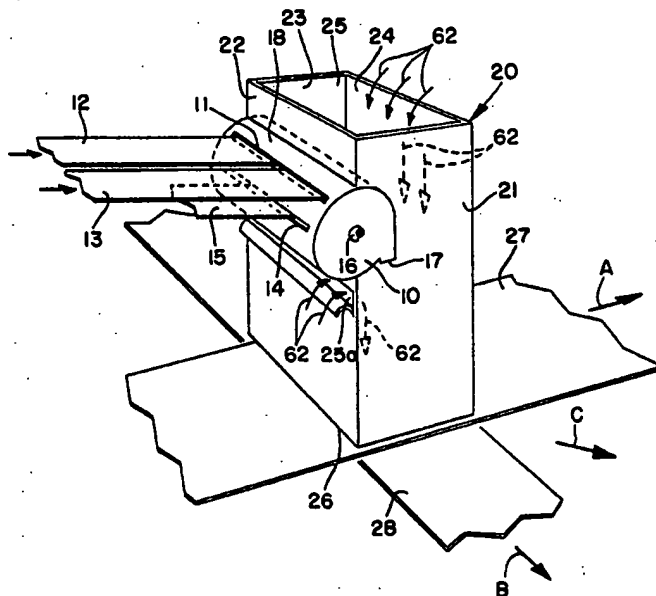
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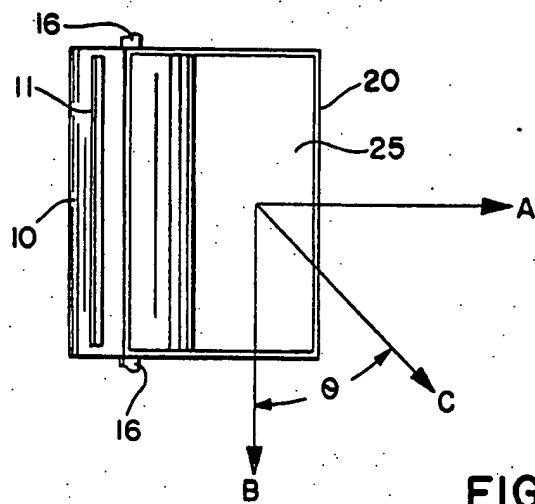
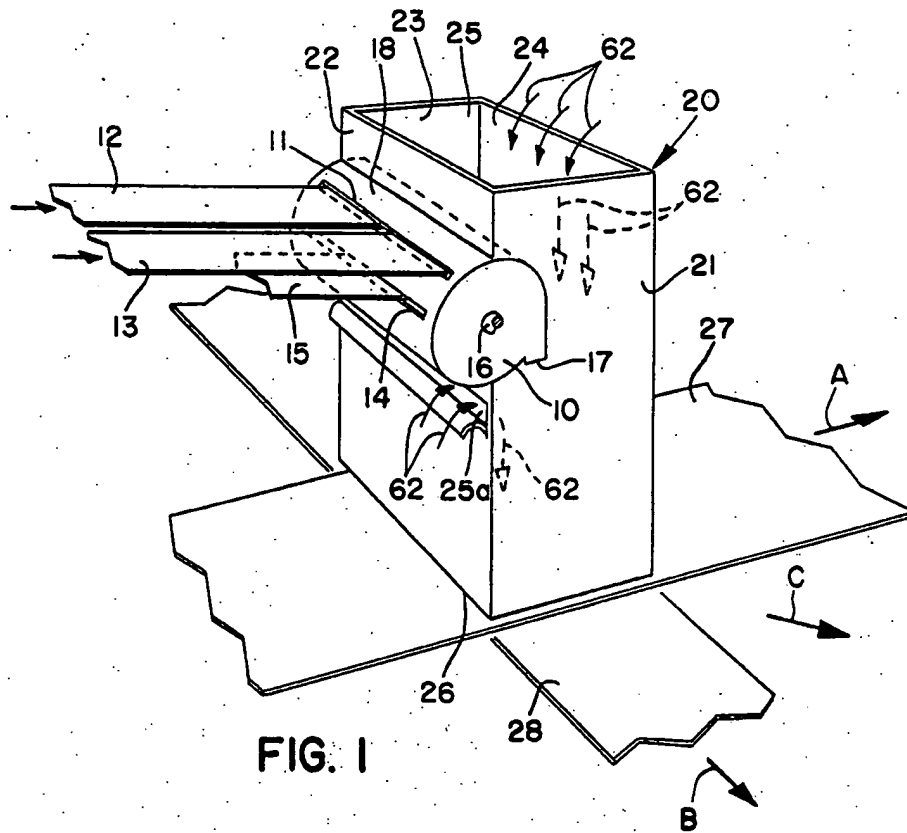
Primary Examiner—Jan H. Silbaugh
Assistant Examiner—Mary Lynn Fertig
Attorney, Agent, or Firm—Paul Yee

[57] ABSTRACT

Apparatus and method for forming an integral laid fibrous web from multiple fiberizable components, characterized by generally discrete homogeneous compositional zones therein. The system comprises a housing having in its outer surface (i) inlet slot(s) for introduction of fiberizable materials into the housing and (ii) a discharge slot generally laterally coextensive with and translationally spaced from the inlet slot(s), for discharge of fiberized materials from the housing. A translatable body is positioned in the housing for translation therein, having a plurality of blades on its outer surface. The outer surface of the translatable body and the housing have a space therebetween wherein the blades travel during translation of the translatable body. First and second fiberizable components are fed to inlet slot(s) wherein the respective fiberizable components are at least partially laterally isolate relative to each other during the feeding. A translatable foraminous forming surface is positioned for receipt of the fiberized materials discharged from the housing through the discharge slot during translation of the forming surface, whereby the discharge fiberized components are laid on the forming surface in generally discrete homogeneous compositional zones of an integral laid fibrous web.

26 Claims, 3 Drawing Sheets





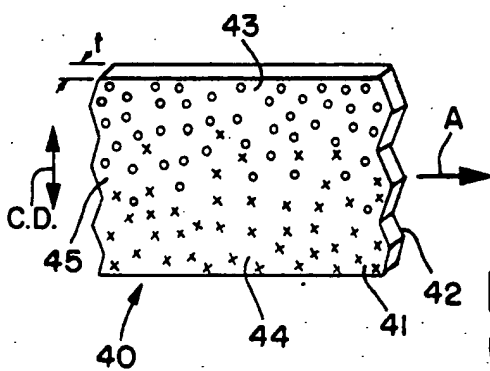
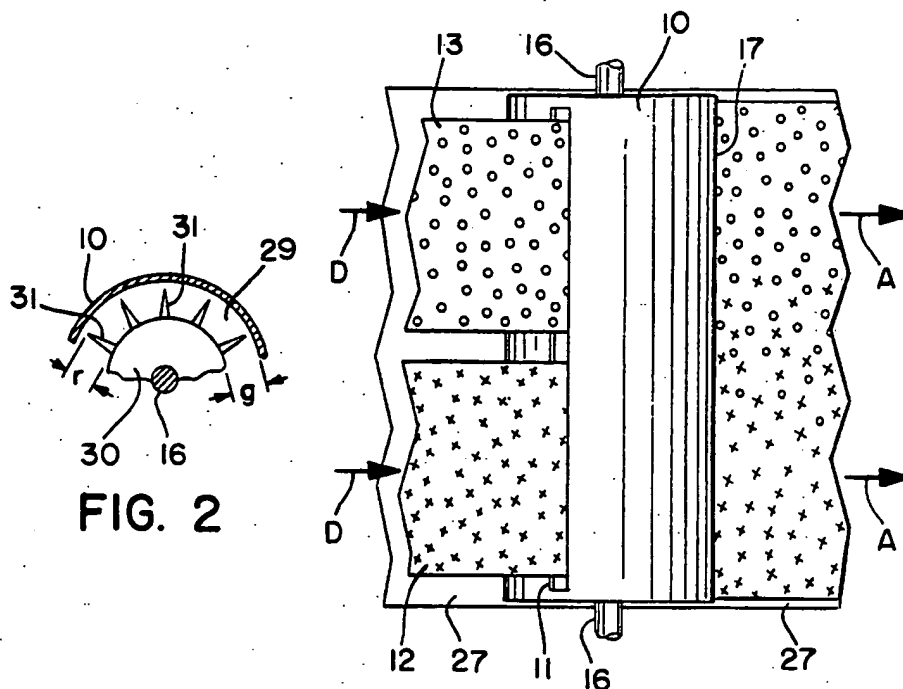


FIG. 4

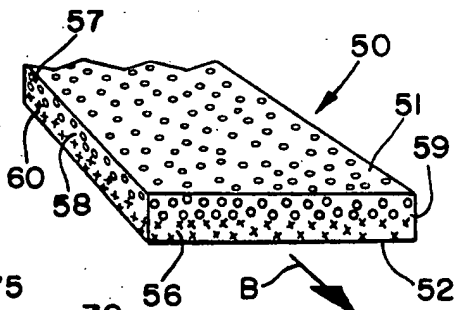


FIG. 5

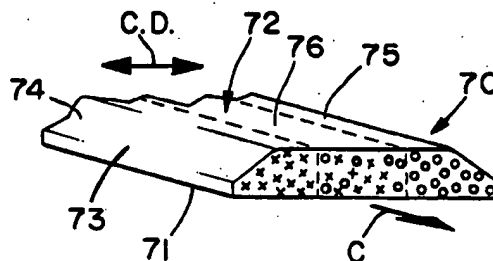


FIG. 6

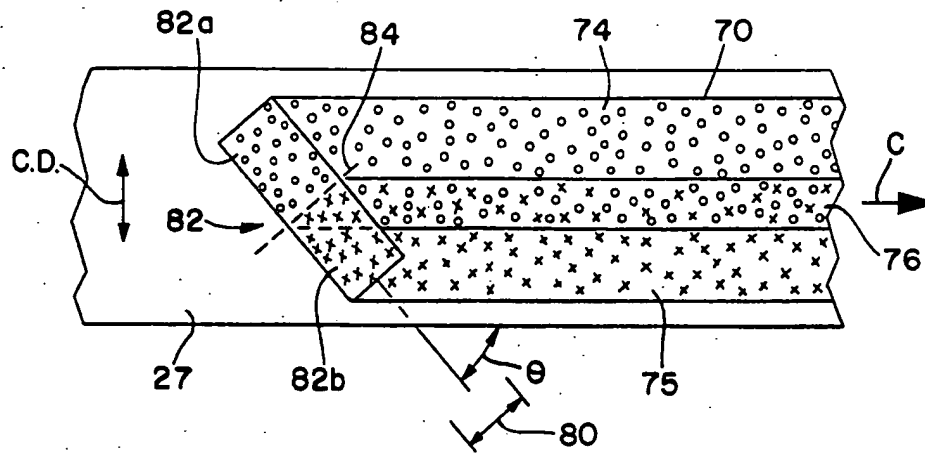


FIG. 7

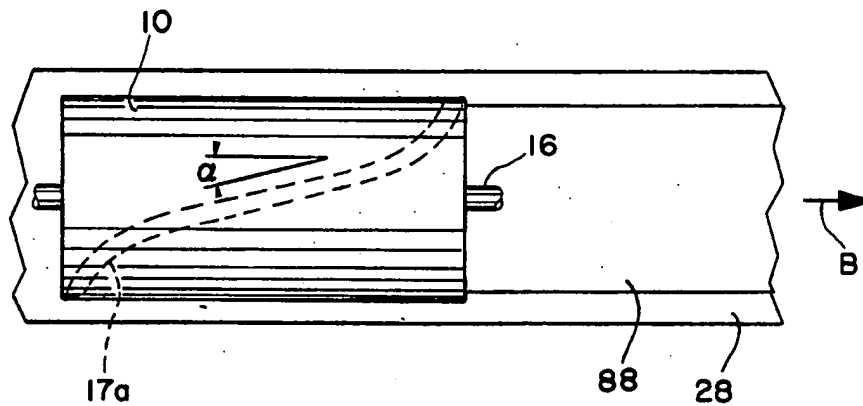


FIG. 8

APPARATUS AND METHOD FOR FORMING A MULTICOMPONENT INTEGRAL LAID FIBROUS WEB WITH DISCRETE HOMOGENEOUS COMPOSITIONAL ZONES, AND FIBROUS WEB PRODUCED THEREBY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention generally relates to apparatus and method for forming an integral laid fibrous web from multiple fiberizable components, and to articles produced thereby. More specifically the invention relates to apparatus and method of such type for forming an integral laid fibrous web with generally discrete, homogeneous compositional zones therein, and to the article formed thereby having laterally extending contiguous zones of different composition.

2. Description of the Prior Art

In the general practice of forming nonwoven fibrous webs, the source material in the form of a fibrous sheet such as pulp sheet, or other fiberizable feed source, is introduced to a fiberizer, wherein the fiber source material is disintegrated, shredded, fiberized or otherwise separated to produce a product material in the form of discrete, individual fibers. The product fibers then are suitably conveyed, for example, by gravity flow, or more commonly, by air-entrainment in a flow stream, onto a foraminous forming surface which may, for example, comprise a wire or screen, e.g., a Fourdrinier wire. The forming surface is translated, or otherwise moved, such as by means of an endless conveyor belt assembly, during the deposition of fibers, to yield the laid fibrous web. The fibrous web article produced thereby has utility in numerous absorbent article applications, such as sanitary napkins and disposable diapers.

In various absorbent article applications, it is desirable to provide a multicomponent fibrous web having discrete zones of different composition. For example, in the case of disposable diapers, it is desirable in some instances to provide a higher basis weight of absorbent material in selected areas of the diaper, and accordingly, it has been common practice to superimpose sequential layers of material in such areas to provide increased thickness and higher absorbency. Further, in forming nonwoven webs of cellulosic fibers, such as in paper-making, it sometimes is desirable to provide different compositional zones in selected products to accommodate different associated treatment steps. For example, different pore size gradients may be formed on different portions of a sheet, or one section of the sheet may be embossed and another section printed.

In many such instances where it is desired to provide a nonwoven fibrous web with multiple discrete compositional zones, it is advantageous for reasons of structural integrity, or ease of manufacture or use, to provide the web as an integral laid structure, as opposed to providing constructions wherein discrete individual layers are superimposed or adhesively bonded to one another. The prior art has proposed various apparatus and methods for producing integral laid fibrous webs with different compositional zones ktherein, but such zones characteristically have been in thickness layers, as opposed to laterally adjacent zones of different composition. In those instances where the prior art has proposed means for forming an integral laid fibrous web with laterally varying composition, the compositional zones are not discrete and homogeneous in form, but

rather the composition varies, linearly or otherwise, across the surface of the web. It, therefore, would be a significant advance in the art to provide an integral laid fibrous web from multiple fiberizable components, which is characterized by generally discrete homogeneous compositional zones in the sheet, wherein the compositional zones are laterally contiguous to one another and have a substantially homogeneous composition throughout the thickness of the web associated with each such zone.

U.S. Pat. Nos. 3,848,589 and 3,975,222 to F. K. Mesek describe the production of an air-laid web by simultaneously feeding to an individualizing station (fiberizer) two continuous strips of compacted fibers, one strip being narrower than and lying along the longitudinal median of the other, with the individualized fibers then being deposited on a moving foraminous belt from an airstream. Longitudinal peaks are provided in the air-laid web by varying the rate of feed of the continuous strips to the individualizing station, to provide a web panel which is double contoured, i.e., centrally contoured in the transverse and longitudinal directions to produce a smooth peak on one major surface. The patent states at column 8, lines 3-10 that alternatively, such longitudinal contour may be imparted to the web by varying the speed of the laydown surface or by grinding fibers at one station to produce a continuous web with a transverse contour and then sequentially grinding selecting amounts of fibers at another station which are deposited on the continuous web to produce repetitive longitudinal contours.

U.S. Pat. No. 3,994,047 to C. A. Lee, et al., discloses the formation of a composite pad from fibers air-laid on a twin-wire machine. A pair of endless foraminous carriers are passed through a forming chamber wherein air-entrained fibers are directed between the carriers, to build up a web structure on each of such carriers. Each of the forming wires has a discrete flow section defining the associated layer of the composite, and the respective carriers converge to join the facing surfaces of the respective web layers to form the composite having a non-uniform cross-section. The formed article illustratively disclosed in the patent is a pad suitable for use in applications such as disposable diapers, comprising a first layer of hourglass shape, and a second layer of ovate shape, which is superimposed on the first layer to provide an increased absorptivity region for the composite article. The patent discloses the provision of fibers from divellicated webs of felted wood pulp, with the fiber source for each of the respective layers of the pad being of the same composition.

French Pat. No. 2,521,602 to Societe Dite Etablissements Ruby, discloses an apparatus for concurrently forming two or more continuous fibrous webs requiring different feed rates. Multiple lay-up drums are coaxially mounted in side-by-side relationship, but driven via speed reduction couplings from the same drive motor at differing speeds. The apparatus is stated to be useful for preparation of complementary layers of composite absorbent fabrics for application such as sanitary pads, diaper linings, etc., having layers of differing compaction. As shown in the drawings of this patent, a compressed layer is supplied at the same output rate as an uncompressed layer for continuous subsequent superposition of the respective layers to produce a composite fabric.

U.S. Pat. No. 3,857,657 to R. K. Teed discloses an apparatus for forming a laid fibrous web in the form of discrete spaced-apart pads on a foraminous forming surface. A wet-pressed pulp fiber sheet is fed into a stationary housing forming a generally enclosed chamber open at its bottom portion, through a slot in the housing. In the housing is mounted a fiberizing device comprising a generally cylindrically-shaped roll having teeth around its outer circumference. The cylindrical roll may be in the form of a plurality of cylindrical disks mounted in side-by-side relationship on a common support shaft, with teeth around the outer periphery or circumference of each of the constituent disks. The resulting discrete fibers travel from the upper portion of the housing onto the forming surface which is in the form of an endless conveyor belt comprising sequential spaced-apart arrays of openings, corresponding to the shape and size of the laid web product. A vacuum suction arrangement acts to impose vacuum suction on the forming surface to cause fiber deposition on the perforated portions thereof. Gas flow conduits are disposed at opposite ends of the forming surface as presented to the fiberizer, and a motor driven fan creates a positive airstream through the region above the forming surface, in turbulent flow, to cause the fiberized fibers to settle only on the perforated portions of the forming surface and to pick up and remove fiberized fibers settling in spaces between the groups of perforations for recirculation to the pad forming area in the lower portion of the chamber defined by the housing. In the disclosed apparatus the longitudinal axis of the cylindrical roll in the housing is aligned parallel with respect to the center line (longitudinal axis) of the forming surface associated therewith, so that the fiber sheet if fed into the housing for fiberization therein, in a direction generally perpendicular to the direction of translation of the foraminous forming surface.

U.S. Pat. No. 3,963,392 to P. K. Goyal discloses an apparatus and method for forming a multicomponent integral laid fibrous web. The apparatus includes plural pairs of spaced parallel, oppositely rotating fiberizers (toothed cylinders), each pair having a movable divider plate therebetween. High speed air-streams flowing past each individual fiberizer entrain the fibers and carry same to a mixing zone between the respective fiberizers to form combined streams, which thereafter enter a common mixing zone above the forming surface, as a composite stream. The divider plates between each pair of fiberizers in this system are adjustable from a range of positions, from a completely withdrawn to a fully downwardly extending position, whereby the degree of intermixing of the entrained fibers in the combined streams may be controlled. A divider plate is also disposed in adjustable relationship with respect to the common mixing zone, to control the degree to which the combined streams intermix in forming a composite stream at the forming surface. The forming surface may define multiple laydown zones associated with individual suction sources which may be independently adjusted to further vary the web formed on the forming surface. The various fiberizer cylinders in this system are oriented with their cylindrical axes perpendicular to the direction of translation of the forming surface.

FIGS. 3-6 in this patent disclose a number of relative configurations of the various divider plates, whereby the web may be laid with sequential layers across its thickness. The patent also discloses at column 9, lines 39-49 that if a fiber collector were disposed immedi-

ately below a mixing zone associated with one pair of fiberizing cylinders, having two distinct components fed thereto on either side of the divider plate, but with the divider plate in a fully retracted position, the resulting web would have a concentration of fibers of one component at one face in excess of the overall concentration of such fibers in the web, with the opposite face of the web having a concentration of the other fibers in excess of the overall concentration of such other fibers in the web, i.e., with the concentration of the first-mentioned fibers gradually and generally linearly diminishing from the respective "enriched" face of the web to its opposite face.

The Goyal patent states that the configuration and density of teeth of the fiberizer cylinder may vary with the specific materials being fiberized. For fiberization of pulp board, the fiberizer cylinder teeth may have a pitch of about $3/32$ - $1/2$ inch, a tooth height of about $3/32$ - $1/2$ inch, and a tooth angle of about -10° to about $+10^\circ$. For fiberization of rayon in the form of a carded batt, the corresponding values are about $1/4$ - $1/2$ inch for tooth pitch, about $1/4$ - $1/2$ inch for tooth height, and about -10° to about $+20^\circ$ for tooth angle. The pulp fiberizer is driven at a rotational speed of 6000 rpm and the rayon fiberizer is driven at 3000 rpm.

U.S. Pat. No. 3,943,605 to E. D. Nystrand discloses an apparatus and method for forming a composite fluff article wherein symmetrically arranged hammermills are fed by separate pulp web rolls, with the resulting fiberized streams being deposited on separate endless wire assemblies. One such laid fibrous layer is removed from its wire by suction and placed with its wire side engaging a wrap sheet traveling beneath the wire on which the second fluff layer is formed. The second layer is removed from its wire by applying suction from beneath, through the wrap sheet and the overlying first layer, to deposit the second layer on the first in inverted relation, i.e., with the respective top surfaces of the sheets as formed being abuttingly mated to form a composite sheet.

U.S. Pat. No. 2,624,079 to T. C. Duvall discloses a system for manufacture of air-laid felts wherein an endless conveyor is disposed beneath a series of deposition chambers. In each chamber a nozzle from a side wall discharges fibers by gravity in a trajectory which provides build-up of thickness of the web, followed by passage of the web through compression rolls to provide a high density, uniform thickness product. It is disclosed at column 5, lines 41-48 of this patent that the disclosed arrangement is flexible, and permits different kinds of materials or different forming conditions to exist in the several chambers, which may be employed in such a way as to build up a symmetrical composite mat which is continuous, but has sequential layers corresponding to the respective deposition chambers. FIG. 3 of this patent shows a composite integral web having outer layers of high grade material such as bleached sulfite fibers, the inner layers being of coarse or unbleached fiber material. It is further disclosed that a bank of injection devices (discharge nozzles) may be provided cross-wise of the web to be formed, i.e., transverse to the direction of translation of the forming surface.

U.S. Pat. No. 2,751,962 discloses a system for producing fibrous products wherein coarse and fine fibers are concurrently incorporated into an integral web. Specifically described is a system for laying of glass fibers from a for hearth of a furnace. A series of orifices in a flow

communication with the forehearth receive molten or flowable fiber-forming material and under the influence of downwardly directed blasts of superheated stream of air impinging thereupon, the molten glass material is drawn or attenuated into fibers which pass downwardly for deposit on an upwardly canted endless belt forming surface. Concurrently, a side stream of the molten material is meltblown and directed in a horizontal direction, by hot high-velocity blasts of gases, onto the forming surface. The downwardly falling coarse and horizontally directed fine fibers intermix on the forming surface, to deposit as a homogeneous nonwoven mixture of the two. The patent discloses that the relatively coarse and relatively fine fiber materials may be different from one another. In another embodiment shown in the patent, in FIGS. 2-3 thereof, coarse fibers are formed in sequential air-blast orifice assemblies longitudinally spaced apart from one another in the direction of translation of the forming surface positioned therebeneath. The forming surface in this embodiment is horizontal; disposed intermediate the respective coarse fiber orifices as a transverse assembly of two restricted orifices associated with means for producing blasts of intensely hot gases therethrough, to form relatively fine fibers. Directly above the forming surface is a shroud which is in fluid flow communication with the orifices generating the respective coarse and fine fibers. The fine and coarse fibers intermingle and mix in the hood, with the mixing augmented by the turbulence of the moving gases therein. In both embodiments a homogeneous mixture of the coarse and fine particles is produced, consistent with the patentee's objective of concomitantly forming and comingling relatively fine and coarse fibers so that the fine fibers tend to pad or cushion the coarse fibers in a manner minimizing inter-abrasion of the fibers, and increasing the insulation value of the composite thereby formed.

U.S. Pat. No. 2,998,051 to K. Sittel discloses a system for forming fibrous articles in which fiber and resin particles are electrostatically combined to form a mat. The system comprises an electrically grounded rotating drum onto which the fiber particles and resin particles are electrostatically collected, with the forming surface disposed between the rotating drum and a pattern electrode disposed therebeneath. A corona electrode initially subjects the fiber particles to a negative electrostatic charge, while corona electrodes impose a positive electrostatic charge on the resin particles. The respective resin and fiber particles are then transferred electrostatically to endless conveyor belts from which a reciprocating trolley comprising electrode plates effects transfer of the resin and fiber particles to the rotating drum for deposition on the forming surface in a pattern corresponding to the pattern electrode beneath the forming surface. In this manner, the fiber and resin particles are said to be deposited with maximum intermingling to form a coherent mat. It is stated at column 3, lines 26-27 of the patent that multiple fiber feeds, in the form of spools of yarn, may be fed to the system.

U.S. Pat. No. 3,128,507 to L. E. Pearson relates to a method of making a nonwoven web from two or more tows of filaments. One tow of fibers is fiberized at a first station, which may, for example, comprise a pair of oppositely rotating bladed cylinders, following which the fibers from the first station are transported onto another tow in a random fashion. The second tow then enters a second station which again may be defined by oppositely or co-directionally rotating bladed cylinders,

wherein the first tow fibers are subjected to secondary fiberization concurrently with fiberization of the second tow. The fiberized fibers of the first and second tows then pass from the second station to a laydown surface such as an endless belt conveyor. The patent discloses that the respective tows can be, and preferably are, different as to at least one feature, such as length, color, size, response to heat or other features.

U.S. Pat. No. 3,753,271 to D. M. McBean describes a random web forming machine wherein a fiberizer comprising a toothed cylinder is disposed in a housing to receive a sheet or mat of fibrous raw stock which is fiberized and subsequent thereto delivered to a venturi passage for flow therethrough under negative pressure differential onto a foraminous forming surface. The fiberizer and forming surface are disposed in a housing defining a continuous flow system, whereby air flow through the forming surface from the venturi is recirculated through the housing to the mouth of the venturi. The forming surface is an endless belt type, mounted so that the direction of travel of the belt can be adjusted angularly with respect to the venturi discharge duct outlet opening. In such manner differing widths of webs can be produced by varying the direction of travel of the forming surface belt with reference to the discharge opening of the duct.

U.S. Pat. No. 3,781,150 describes a system for producing multilayer fibrous mats, wherein the layers are integrally held together by interfiber bonds at their interfaces under the influence of suction air. A source of pulp fibers is introduced into the system from a shredding unit, in undispersed form, to a disintegrator which produces finely separated short-length fibers. The disintegrator comprises a cylindrical housing containing an axial array of blade runners superimposed upon one another at random angles to form a blade assembly. The blade assembly is disposed in a subhousing formed by a perforated cylindrical wall, through which the disintegrated finely separated short-length fibers are distributed. Air flows into and through the housing by means of an elongate slit communicating with the atmosphere and extending axially on opposite sides of the casing, in association with air intake and damper assemblies at the upper end of the casing. An endless belt foraminous forming surface is disposed beneath the casing to receive fibers passing through the perforated wall under the influence of air flow through the casing and forming surface, to suction boxes disposed beneath the forming surface. A defibrator is associated with the disintegrator to produce long fibers, the defibrator extending substantially the full length of the disintegrator unit. A long-fiber forming lap is defibrated by a toothed wire into finely separated individual fibers which pass through a funnel-like passage axially communicating with a lower portion of the casing, for flow therethrough and deposition on the forming surface. The forming surface is translated in a direction such that long fibers are first deposited on the forming surface followed by fine fibers, and optionally gain by long fibers. The long fibers in this system thus are not produced in the same fiberizer unit as the short fibers, but pass through separate channels in the casing for sequential deposition on the forming surface.

In U.S. Pat. No. 4,268,340 to H. G. Fitzgerald, et al., there is disclosed an apparatus for forming an absorbent web comprising a matrix of hydrophilic and hydrophobic materials derived as wastes in the manufacture of disposable absorbent articles, whereby the waste mate-

rials may be recycled and utilized for forming such articles. Alternatively, the feed materials may be virgin hydrophobic and hydrophilic materials. In either event, the feed materials are conveyed to a shredder, comprising a plurality of axially spaced blades mounted on a common shaft, each of the blades having projecting teeth spaced around the periphery of the blades. The resulting shredded material then is air-entrained and conveyed to a cyclone separator, wherein heavier shredded particles are collected and conveyed to a fiberizer, which may be a pin cylinder. The fiberizer reduces the particles passing thereto into a finer size as particles, shreds and fibers, including hydrophilic and hydrophobic material, which then are drawn, via air-entrainment, onto a foraminous forming surface, to provide a nonwoven web comprising such hydrophilic and hydrophobic materials.

U.S. Pat. No. 4,018,646 to A. P. Ruffo, et al., discloses a system which is similar to that of U.S. Pat. No. 3,963,392 to P. K. Goyal, except that only a single pair of fiberizing drums is employed, each associated with the feed of a single component, illustratively described as being pulp on one side and staple fibers on another. A vertically movable baffle is translatable between the respective fiberizing drums to vary the degree of mixing cross-over of the components and produce a variety of nonwoven fabrics, such as a web having a predominance of one fiber type at one of its major faces and a predominance of the other fiber type at the other of its major faces, with a transition between the respective faces in which the predominance of fibers decreases uniformly away from the face at which they predominate. Alternatively, it is possible to form nonwoven webs characterized by essentially discrete layers of the respective components, corresponding to the operation of the apparatus when the central baffle is downwardly most extended.

U.S. Pat. No. 3,952,124 to F. K. Mesek discloses the utilization of dual systems, each of the type as shown in Ruffo, et al., U.S. Pat. No. 4,018,646 to produce a composite multi-layer web therefrom. The dual fiberizer drum assembly having a baffle plate disposed therebetween is utilized to form a first web portion having one face enriched in long fibers and the other enriched in short fibers with the concentration of long and short fibers decreasing substantially uniformly from the enriched faces to form a transition region therein. Similar apparatus is employed to form a second web portion which preferably is the same as the first portion and is bonded thereto in mirror image (back-to-back) relationship, so that the long fiber enriched faces are outwardly disposed to provide substantial structural integrity to the formed web article.

As shown by the foregoing, the art has proposed numerous apparatus and methods for forming integral laid fibrous webs from multiple fiberizable components. These components are either completely intermixed or comingled with one another to produce a substantially homogeneous composition throughout the laid article, or the separate components are laid down in a sequential or partially mixed manner to provide laid fibrous webs with thickness layers of different composition.

SUMMARY OF THE INVENTION

One aspect of the present invention relates to an apparatus for forming an integral laid fibrous web from two or more fiberizable components. The fibrous web has multiple, demarcated, generally discrete homogeneous

compositional zones therein. The apparatus includes: a housing having in its outer surface (i) inlet means for introducing fiberizable materials into said housing and (ii) exit means, which is spaced from and is generally laterally coextensive with said inlet means for discharging fiberized materials from said housing; a translatable body positioned in the housing for movement therein and having a plurality of blades on its outer surface, with the outer surface of the translatable body and the housing having a space therebetween wherein the blades travel during the movement of the translatable body; means for feeding a first fiberizable component to the inlet means; means for feeding at least a second fiberizable component to the inlet means in an arrangement that at least partially laterally isolates the second fiberizable component from the first fiberizable component; a movable and translatable foraminous forming surface positioned for receipt of the fiberized materials discharged from the housing through the discharge and drive means for moving the translatable body in the housing; wherein the blades and the space between the translatable body and the housing are dimensionally sized, and the drive means for the translatable body is capacitively sized, to substantially avoid lateral interdispersion between fibers of the first and second components in the housing, whereby the fiberized components discharged from the housing onto the foraminous forming surface during the movement thereof are laid thereon to form generally discrete homogeneous compositional zones of an integral laid fibrous web.

In another aspect of the invention, the housing and translatable body each have cylindrical geometries, with the apparatus comprising: a cylindrical housing having in its outer cylindrical surface (i) longitudinally extending inlet means for introducing of fiberizable materials into the housing and (ii) a longitudinally extending discharge means generally longitudinally coextensive with and circumferentially spaced from said inlet means, for discharging fiberized materials from the housing; a rotatable cylindrical body concentrically positioned in the housing for rotation therein about its cylindrical axis and having a plurality of radially extending, circumferentially spaced-apart blades on its outer cylindrical surface, such blades having a radial extent defining a first radial dimension, with the cylindrical body and cylindrical housing having an annular space therebetween defining a second radial dimension not substantially larger than the first radial dimension; means for feeding a first fiberizable component to the inlet means; means for feeding at least a second fiberizable component to the inlet means in an arrangement that at least partially axially isolates the second fiberizable component from the first fiberizable component; a translatable foraminous forming surface positioned for receipt of the fiberized materials discharged from the cylindrical housing through the discharge slot; and means for rotating the rotatable cylindrical body in said cylindrical housing, at a rotational speed sufficient to substantially avoid axial or longitudinal interdispersion between the first and second components therein, whereby the fiberized components discharged from the cylindrical housing onto the foraminous forming surface during translation thereof are laid thereon in generally discrete, homogeneous compositional zones constituted within an integral laid fibrous web.

In a particular aspect of the invention, the inlet means for introducing fiberizable materials into the housing is a single longitudinal inlet slot, with the aforementioned

means for feeding a first fiberizable component to the inlet means, serving to feed such component to a first longitudinal segment of the single slot, and with the aforementioned means for feeding the second fiberizable component to the inlet means, serving to feed same to the second longitudinal segment of the inlet slot that is distinct from the first longitudinal segment thereof.

In another apparatus aspect of the invention, the inlet slots comprise discrete slots, with the first fiberizable component fed by the feeding means to the first inlet slot, and the second fiberizable component being fed by feeding means to a second inlet slot distinct from the first inlet slot.

Another aspect of the invention relates to a method for forming an integral laid fibrous web from multiple fiberizable components. The fibrous web is characterized by demarcated generally discrete homogeneous compositional zones therein, and the method includes the steps of: providing a housing having in its outer surface (i) inlet means for introduction of fiberizable materials into the housing and (ii) discharge means spaced from and generally laterally coextensive with the inlet means, for discharging fiberized materials from the housing; positioning a translatable body in the housing for movement therein and providing a plurality of blades on its outer surface, with the outer surface of the translatable body and the housing having a space therebetween wherein the blades travel during movement of the translatable body; positioning a translatable foraminous forming surface for receipt of the fiberized materials discharged from the housing through the discharge slot; feeding a first fiberizable component to the inlet means; feeding at least a second fiberizable component to the inlet means in an arrangement that at least partially laterally isolates the second fiberizable component from the first fiberizable component; translating the foraminous forming surface; moving the translatable body in the housing at a translational speed sufficient to substantially avoid lateral interdispersion between the fiber the first and second component therein; and discharging the fiberized materials from the housing through the discharge means onto the foraminous forming surface during movement thereof, whereby the fiberized components discharged from the housing onto the foraminous forming surface during movement thereof are laid thereon to form generally discrete homogeneous compositional zones of an integral laid fibrous web.

In yet another aspect of the invention, the housing and translatable body have a cylindrical geometric shape, and the method of the invention comprises the steps of: providing a cylindrical housing having in its outer cylindrical surface (i) longitudinally (axially) extending inlet means for introduction of fiberizable materials into the housing and (ii) a longitudinally (axially) extending discharge means generally longitudinally (axially) coextensive with the circumferentially spaced from the inlet means, for discharging fiberized materials from the housing; concentrically positioning a rotatable cylindrical body in the housing for rotation therein about its cylindrical axis and having a plurality of radially extending, circumferentially spaced apart blades on its outer cylindrical surface, the blades having a radial extent defining a first radial dimension, with the cylindrical body and the cylindrical housing having an annular space therebetween defining a second radial dimension not substantially larger than the first radial dimension; positioning a translatable foraminous form-

ing surface for receipt of the fiberized materials discharged from the cylindrical housing through the discharge slot; feeding a first fiberizable component to the inlet means; feeding at least a second fiberizable component to the inlet means in an arrangement that at least partially axially isolates the second fiberizable component from the first fiberizable component; translating the foraminous forming surface; rotating the rotatable cylindrical body in the cylindrical housing at a rotational speed sufficient to substantially avoid longitudinal (axial) interdispersion between the fibers of first and second fiberizable components therein; and discharging fiberized materials from the cylindrical housing through the discharge slot onto the foraminous forming surface during translation thereof, whereby the fiberized components discharged from the cylindrical housing onto the foraminous forming surface during translation thereof are laid thereon to form generally discrete homogeneous compositional zones constituted within the integral laid fibrous web.

Analogous to the specific form of the inlet slot(s) as described above in connection with the apparatus aspects of the invention, the method as respective preferred embodiments wherein, in one embodiment, the first and second fiberizable components are fed to first and second distinct longitudinal segments of a single inlet slot; in another preferred embodiment, separate longitudinally extending slots, circumferentially spaced apart from one another, are utilized for introduction of the respective first and second components into the casing for fiberization therein.

In an article aspect the present invention relates to an integral laid fibrous web having top and bottom surfaces defining the thickness of the web, with at least two demarcated, generally discrete laterally extending contiguous zones therein of differing composition, each said zone having a substantially homogeneous composition throughout the thickness of the web associated with such zone.

Generally, the present invention provides improved apparatus and method for forming an integral laid fibrous web from multiple fiberizable components characterized by generally discrete, homogeneous compositional zones therein.

The apparatus and method of the invention are capable of producing an integral fibrous web wherein the boundaries between adjacent compositional zones are sharply defined.

The present invention also provides an integral laid fibrous web with multiple laterally extending zones of differing composition, wherein each zone has a substantially homogeneous composition throughout the thickness of the web.

Compared to conventional fibrous webs comprised of layers, the fibrous web of the invention can have greater resistance to separation at the interface between different components, greater strength, and greater resistance to delamination. In addition, the interfacial region, which demarcates a connective border between the components of the fibrous web of the invention, can be selectively controlled to adjust the degree of mixture of the component fibers in the interface region.

Other aspects and advantages of the present invention will be more fully apparent from the ensuing disclosure and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and elements of the present invention will be more fully appreciated with respect to the appended drawings, wherein:

FIG. 1 is a simplified perspective view of the apparatus of the present invention, representatively showing three different directions for translation of the foraminous forming surface, relative to the longitudinal axis of the rotatable cylindrical body, in the cylindrical housing defining the fiberization chamber;

FIG. 1a representatively shows a top plan view of the apparatus illustrated in FIG. 1;

FIG. 2 is a partial sectional elevational view of the rotatable cylindrical body disposed in the cylindrical housing of the fiberization chamber;

FIG. 3 is a partial plan view of the cylindrical housing of FIG. 1;

FIG. 4 is a plan view of the section of the integral laid fibrous web, produced by means of the apparatus of FIG. 1, utilizing the foraminous forming surface 27;

FIG. 5 is a perspective view of an end section of an integral laid fibrous web formed by the apparatus of FIG. 1, utilizing the foraminous forming surface 28;

FIG. 6 representatively shows a perspective view of an end section of an integral laid fibrous web formed with the apparatus of FIG. 1 while moving the foraminous forming surface in the C-direction;

FIG. 7 representatively shows the effect of the fiber stream thickness on the interface region of the laid fibrous web; and

FIG. 8 representatively shows a curvilinear discharge opening formed in a fiberizer housing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown a simplified perspective view of an apparatus for forming an integral laid fibrous web from multiple fiberizable components. This web is characterized by generally discrete, homogeneous compositional zones therein. In the illustrated apparatus, a cylindrical housing 10 has in its outer cylindrical surface 18 longitudinally extending inlet means, such as an opening or slot 11 and optional slot 14, for introduction of fiberizable materials into the housing. The housing also features a longitudinally extending exit means, such as an opening or slot 17, which is generally longitudinally coextensive with and circumferentially spaced from the inlet slot(s), for discharge of fiberized materials from the housing.

The discharge outlet slot should be substantially free of obstructions, such as screens and baffles. Obstructions at the discharge slot can restrict the exit and deflect the trajectories of fibers from the housing to cause undesired intermixing of the different fibers. In addition, the presence of obstructions can undesirably recirculate the fibers through the annulus with the rotor and cause further intermixing.

In one embodiment of the invention, as generally shown in FIG. 1, slot 14 is deleted and only slot 11 is employed to feed fiberized materials into the housing. As shown, slot 11 is being fed with separate, generally parallel aligned sheets of fiberizable materials, 12 and 13. These respective fiberizable sheets may be of staple fibers, pulp, or other cellulosic material, or polymeric, fabric or any other fiberizable materials which suitably may be processed for formation of a nonwoven web, or may be utilized as an adjuvant, additive or dispersant in

the web composition. The respective sheets 12 and 13 may be fed from a suitable feeding means (not shown) such as fiber sheet rolls utilized in conjunction with endless conveyor belts and/or guide rolls, to translate the respective fiber sheets into the feed slot(s) of the housing 10.

It is a central feature of the present invention that the respective, e.g. first and second, fiberizable components, such as sheets 12 and 13 in FIG. 1, be fed to an inlet slot in the cylindrical housing, such that the respective fiberizable components are at least partially laterally isolated from each other. In application to the FIG. 1 embodiment, if only inlet slot 11 is used, as a single longitudinally extending inlet slot for ingress of fiberizable materials into the housing 10, the criterion that the first and second fiberizable components are at least partially laterally isolated, means that the respective components are fed into the slot so that there is at most only a partial lateral, edge-to-edge overlap, or, in terms of the cylindrical housing geometry shown, a partial axial overlap therebetween. The lateral direction (or, in the FIG. 1 system, the axial direction) is the direction transverse to the direction of feed of the fiberizable materials into the housing. Preferably, as shown in FIG. 1, there is no axial overlap of the fiberizable materials, i.e., the first fiberizable component is fed to a first longitudinal segment of the inlet slot and the second fiberizable component is fed to a second longitudinal segment of the inlet slot, distinct from the first longitudinal segment thereof.

In an alternative embodiment of the invention, the outer cylindrical surface 18 of the cylindrical housing 10 may have longitudinally extending inlet slots 11 and 14 therein, circumferentially spaced apart from one another, with a first fiberizable component being introduced into one slot and a second fiberizable component being introduced into the other slot. Thus, a single sheet of fiberizable material could be fed into slot 11 as the first component; alternatively, as shown the twin sheets 12, 13 may be fed into the slot 11, concurrently with the feeding of another fiberizable component 15 into inlet slot 14.

In the embodiment wherein plural, longitudinally-extending slots are employed to provide the inlet means into the interior of housing 10, the terms "at least partially laterally isolated" or "at least partially axially isolated," used in reference to the respective fiberizable components, means that the respective fiberizable components are not laterally (axially) coextensive in length at the housing outer surface, i.e., there is no complete lateral (axial) overlap of the fiberizable materials fed to the respective slots. This is shown in the alternative embodiment illustrated in FIG. 1, wherein slots 11 and 14 are disposed on the housing's outer cylindrical surface 18, but wherein the width or transverse extent of the laid web, measured along the axial direction at the cylinder's outer surface, is not wider than the width of the sheet(s) fed to the upper inlet slot 11. Stated another way, the fact that the respective fiberizable components are at least partially laterally (axially) isolated from one another means that there is at most only a partial lateral (axial) overlap between them (note that the fiberizable sheet(s) introduced by slot 11 into the cylindrical housing 10 overlaps the fiberizable material 15 introduced into the cylinder in slot 14 only at the central portion of the top sheet(s), with the marginal portions of the top sheet(s) being "axially isolated" from the lower sheet).

In further aspects of the invention, additive materials, such as solid particulates or liquids, may be dispersed or otherwise incorporated into the formed web. For example, the method and apparatus of the invention may be employed to distribute superabsorbent particles within the web. A representative technique for accomplishing this would include an appropriate sizing of slot 14 and a repositioning of the slot to a selected axial location on housing 10. The desired additive material would be introduced through slot 14, while the fiberizable components would be introduced through inlet slot 11.

As another example, a suitable liquid material could be dispersed into the interfacial region between different components. This liquid material could then react with the different fibers to produce a chemical cross-linking therebetween.

The cylindrical housing 10 contains a rotatable cylindrical body, described more fully hereinafter, which is mounted on a longitudinally extending shaft 16, whereby the rotatable cylindrical body may be rotated by suitable drive means (not shown) which may comprise electrical motor or other drive means, to effect fiberization of the fiberizable materials introduced into the slot(s) of the housing 10. The resulting fiberized material is discharged from the housing through longitudinally extending discharge slot 17 which is generally longitudinally coextensive with and circumferentially spaced from the inlet slot(s). By characterizing the discharge slot as generally laterally or longitudinally coextensive with the inlet slot(s), it is meant that the discharge slot has a lateral (longitudinal) dimension which is at least as great as the lateral (longitudinal) dimension of the slot or slot(s) which are utilized to feed fiberizable materials into the housing. Thus, in the FIG. 1 embodiment, the discharge slot 17 has a length measured along the outer cylindrical surface 18 of the housing 10 which is equal to the length of inlet slot 11.

Positioned beneath the cylindrical housing 10 to receive fiberized materials discharged therefrom through the discharge slot 17 is a translatable foraminous forming surface, which may be of conventional type such as an endless belt forming screen or Fourdrinier wire surface. The forming surface may comprise the foraminous forming surface 27, which is translated in the direction shown by the Arrow A. The cylindrical axis of cylindrical housing 10 is positioned generally transversely to the direction of translation of the foraminous forming surface 27, here being perpendicular to such direction of translation.

Alternatively, the forming surface disposed to receive the fiberized materials discharged from the cylindrical housing 10 through the discharge slot 17 may comprise the foraminous forming surface 28, in place of the forming surface 27. The forming surface 28, may be of any suitable type analogous to the forming surface 27, and is translated in the direction shown by Arrow B. In such manner, the cylindrical axis of the cylindrical housing 10 is positioned in a generally unidirectional and parallel alignment with the direction of translation of the foraminous forming surface, here being generally parallel to such direction of translation.

In still another configuration of the apparatus of the invention, the movable forming surface is translated in a diagonal direction shown in FIGS. 1 and 1a by the Arrow C. This diagonal orientation of the forming surface movement direction relative to the cylindrical axis of housing 10 corresponds to the intermediate arrangements between the generally "perpendicular" and

generally "parallel" orientations described above. As representatively shown in FIG. 1a, the amount of diagonal or angular offset, "theta", can be selectively controlled to adjust the amount of mixture and overlap between the fibers of the two components within interface region 76 (FIG. 6). The cross-directional width of the interface region between the two components can be increased or decreased, as desired, by decreasing or increasing the angle, "theta", measured between the movement direction of the forming surface and the axial direction of the cylindrical housing. This adjustment technique can be employed to create a substantially flat, edge-to-edge, cross-sectional profile across the CD width of the interface region of the formed web. For example, FIG. 6 representatively shows an integral laid fibrous web formed from two different materials which have been fed into housing 10 with substantially no axial overlap or separation therebetween. Interface region 76 contains a mixture of the two materials and has essentially the same basis weight as the remainder of the fibrous web.

The technique can also be employed to create a selected basis weight variation, as measured along the cross-direction (CD) of the formed web, by regulating the amount of overlap between the webs of material being fed into the housing. Increasing the amount of overlap produces an increased basis weight over a greater portion of the CD width of the formed web.

In addition to diagonally orienting the axis of cylindrical housing 10, the CD width of interface region 76 can also be controlled by regulating the "thickness" of the stream of fibers deposited onto forming surface 27. This fiber stream thickness is the dimension of the fiber stream that is measured perpendicular to the rotor axis. FIG. 7 illustrates the relationship between the angle "theta" and the CD width of interface region 76. As "theta" increases, the width of the interface region decreases. In the illustrated embodiment, fiber stream portion 82a is composed of a first fiber component, fiber stream portion 82b is composed of a second fiber component and dotted line 84 indicates the approximate boundary between the different fiber components.

The thickness of the fiber stream can be regulated by adjusting the relative difference between the fiber stream velocity and the velocity of a merging air stream 62 passing through flow housing 20. This merging air stream moves adjacent to the fiber stream and is drawn into housing 20 through inlets 25 and 25a. If the fiber stream velocity is substantially equal to the merging air stream, the thickness of the fiber stream remains substantially unchanged as it moves from discharge opening 17 to forming surface 27. If the fiber stream velocity is greater than the merging air stream velocity, the thickness of the fiber stream will increase as the fiber stream moves from the discharge slot to the forming surface. The greater the difference in the relative velocities, the greater the increase in the fiber stream thickness. The difference in relative velocities, however, should not be so great that it causes undesired recirculating gas flows within the flow housing 20.

When the invention is configured to move forming surface 28 along direction B, a laid fibrous web having a substantially flat, edge-to-edge cross-sectional profile across the CD width of the formed web can be produced by employing a discharge slot that is angularly offset relative to the axis of the fiberizer rotor, as illustrated in FIG. 8. Instead of being essentially parallel to rotor axis 16, the discharge slot is oriented at an offset

skewed angle "alpha" relative to the rotor axis. As a result, the discharge opening has a curvilinear configuration that is approximately helical in form. This curvilinear discharge slot duct opening 17a is oriented to open toward along a direction that generally faces toward forming surface 28, and is capable of directing a fibers stream to form a fibrous web 88 which has a CD width approximately equal to the diameter of the fiberizer. The precise CD profile of the formed web can be varied and will depend upon the particular flow velocities of the fiber stream and the particular curvilinear shape of the discharge slot.

The configurations in which the movement of the forming surface is aligned along directions B or C are particularly advantageous for producing high basis weight fibrous webs. The basis weight of the formed fibrous web can be increased by increasing the axial length of the fiberizer rotor portion of the invention. Increasing the length of the fiberizer rotor increases the total throughput of material onto the forming surface, but does not increase the throughput of material per unit length of axial rotor length. Eliminating the need to increase the throughput of material per unit length of rotor length reduces the possibility of incomplete fiberization of the material within housing 10.

The amount or degree of merging and blending in the interface region of the formed web can also be adjusted to control the interfacial or boundary resistance between the different fibrous components of the web. In particular, increasing the degree of mixing of the different fibers in the interface region can reduce the boundary resistance between the components. The term "boundary resistance" is meant to encompass the differences in physical and chemical properties between the components which would affect the absorptive characteristics of the fibrous web. Such physical and chemical properties would include, for example, high and low surface energy properties, and pore size gradients.

The FIG. 1 apparatus shows a representative means for combining the fiberized components discharged from the cylindrical housing 10 through the discharge slot 17, with a merging air stream, and channeling the merged air and fibers stream onto the foraminous forming surface, without substantial mixing of fiberized components transverse to the direction of flow of the stream. Such means comprise the flow housing 20 bounded by the walls 21, 22, 23 and 24, and presenting a generally rectangular cross-section when viewed in plan view at the air inlet face 25, viewing downwardly toward the fibers outlet face 26. Thus, the flow housing 20 in its interior defines a flow channel in fibers flow communication with the discharge slot 17 of the cylindrical housing 10. Vacuum box or other suction means may be disposed beneath the forming surface 27 or 28 in proximity to the outlet face 26 of the flow housing, whereby merging air is flowed into the flow housing 20 at the inlet face 25 to merge and combine with the fibers discharged from slot 17. It is important that the volumetric air flow through the flow housing be characterized by a substantially uniform velocity profile, of the air flow across the inlet and outlet faces 25 and 26, respectively. This helps insure that substantially no longitudinal interdispersion occurs between the respective discharged fiberized materials prior to their deposition on the forming surface.

In addition, air may be introduced into a selected portion of housing 10, such as the top of the housing, in a manner conventionally employed in the art to provide

a supplemental gaseous transporting medium therein. In a particular embodiment of the invention, this supplemental gaseous transporting medium is forced into housing 10 along a path which is generally tangential to the surface of the fiberizer rotor and co-directional with the movement of the rotor surface within the housing.

FIG. 2 illustrates a sectional, elevation view of the portion of the cylindrical housing 10 showing the interior elements thereof. The cylindrical housing 10 has disposed therein a rotatable cylindrical body 30 concentrically positioned in the housing for rotation about its cylindrical axis, by virtue of the concentrically mounted drive shaft 16. A plurality of radially extending, circumferentially spaced-apart blades 31 are positioned on the outer cylindrical surface of the rotatable body 30. These blades have a radial extent defining a first radial dimension denoted as "r" in the drawing, with cylindrical body 30 and the cylindrical housing 10 having an annular space 29 therebetween defining a second radial dimension, denoted in FIG. 2 as "g", which is not substantially larger than the first radial dimension, "r".

In practice, the first radial dimension, r, which is the height of the radially extending blades, measured along a radius of the cylindrical casing from a point on the surface of the rotatable body 30, may be on the order of one inch.

The second radial dimension, g, which is the annular cylindrical wall-to-cylindrical surface distance, as measured therebetween along a radius of the cylindrical housing, may be on the order of 1.125 inch. In preferred practice the ratio of the first radial dimension, r, to the second radial dimension, g, is in the range of from about 0.7 to 0.98, and most preferably in the range of from about 0.8 to 0.95.

The bladed, rotatable cylindrical body 30 may suitably have peripheral teeth arranged in bands extending transversely and around the rotor axis. The tooth pattern in each band can extend circumferentially in an approximately sinusoidal wave shape on the rotor periphery to provide impact distributed in simple harmonic motion along the cross-direction impact line of the sheet fed through the infeed slot into the casing.

The rotatable cylindrical body 30 is mounted on a suitable drive shaft 16, and may be driven by electrical motor or other drive means to provide a peripheral speed at its outer cylindrical surface which is sufficient to produce the fibers of the first and second components as they move through in the annular chamber in the cylindrical housing. In such manner, the fiberized components discharged from the cylindrical housing 10 onto the foraminous forming surface 27 or 28 during translation thereof are laid thereon in generally discrete homogeneous compositional zones constituted within an integral laid web. For the aforementioned illustrative embodiment wherein r is one inch and g is 1.125 inch, the peripheral surface speed is at least 6,000 fpm, and more generally, peripheral surface speeds on the order of from about 16,000 to 30,000 fpm have been found suitable in the broad practice of the present invention.

In the operation of the apparatus as shown in FIGS. 1-2, the fiberizable materials, such as a hardwood pulp sheet 12 and a softwood pulp sheet 13, or an upper single hardwood pulp sheet in slot 11 and a lower softwood pulp sheet in slot 14, are introduced into the cylindrical housing, wherein the bladed cylindrical body 30 is rotated at suitable speed, consistent with the dimensions r and g, to fiberize the respective components in the housing, within the annular space. Pulp sheets 12

and 13 are fed through their respective input slots with a relative arrangement in which the pulp sheets are at least partially laterally isolated from each other. In addition, any unused feed slots are plugged or otherwise covered to prevent the blowing of fibers out through the slots. The fiberized components discharged from the cylindrical housing onto the forming surface 27 or 28 during translation thereof are laid on the forming surface in generally discrete homogeneous compositional zones of the laid nonwoven fibrous web. It will be appreciated that the extent of longitudinal interdispersion of fibers in the annular space for the housing 10, under the influence of fiberizing blade elements 31, will be a function of the rotational speed, and dimensions r and g , as well as the fiberizability of the fibrous components introduced into the casing. Accordingly, one of the ordinary skill may, without undue experimentation, employ a few trial runs to determine the extent of lateral (axial) dispersion in the web forming system and adjust same so as to minimize lateral (axial) interdispersion therein to a desired level.

Upon fiberization of the respective components introduced into the housing 10, the resulting discrete fibers are circumferentially translated to the discharge slot 17 and discharged into the flow housing 20, to be merged with the air stream entering at inlet face 25 and 25a, as previously described. A suitable vacuum box or other suction means (not shown) may be disposed beneath the forming surface 27 or 28 to impart a negative pressure on the surface to draw the air component of the air-fibers stream therethrough, leaving the fibers deposited on the forming surface. Inasmuch as the fiberizable materials introduced into the housing 10 are fiberized therein without significant longitudinal (axial) mixing within the annular space thereof, the effluent or discharge stream of fiberized materials leaving the housing 10 through slot 17 has a composition along the axial direction which is essentially commensurate and in a substantially one-to-one correspondence with the compositions of the fiberizable components at the inlet slot(s) of the housing 10. Thus, it is possible to lay down on the forming surface a fibrous web which has highly discrete compositional zones contiguous to one another, as described more fully hereinafter.

FIG. 3 illustrates a top plan view of a portion of the FIG. 1 apparatus, comprising the cylindrical housing 10 and the drive shaft 16. The FIG. 3 embodiment utilizes feed of two materials, sheets 12 and 13 into the housing through slot 11, in the direction shown by Arrows D. The resulting fiberized materials then are discharged downwardly from the cylindrical housing 10 through discharge slot 17 onto the foraminous forming surface 27 being translated in the direction denoted by Arrows A.

FIG. 4 is a perspective view of a laid fibrous web 40 formed from sheets 12 and 13 by the apparatus as shown in FIG. 3. The fibrous web 40 has a top surface 41 and a bottom surface 42 defining the thickness of the web, as the distance therebetween, denoted "t". This integral laid fibrous web has two generally discrete, laterally extending contiguous zones 43 and 44 therein of differing composition, zone 44 corresponding compositionally to sheet 12, and zone 43 corresponding compositionally to sheet 13 and a very small interlayer or boundary area 45 therebetween corresponding to a mixed composition derived from the materials of sheets 12 and 13, respectively. As used herein in reference to the compositional zones of the laid fibrous web, the

term laterally extending means that such zones extend partially or fully across the web top and bottom surfaces. Thus, each of the contiguous side-by-side zones 43 and 44 has a substantially homogeneous composition throughout the thickness of the web associated therewith, i.e., the respective zones are generally discrete and compositionally homogeneous, with a comparatively sharp boundary at 45.

FIG. 5 shows a perspective view of the end segment of another fibrous web laid using the apparatus of FIG. 1, but with forming surface 28 as the sole laydown surface for the web. Again, the web is formed by parallel fed sheets 12 and 13, but with the forming surface 28 being translated in a direction generally parallel to the axis of the cylindrical housing 10. Thus, Arrow B is shown in FIG. 5 for reference as the direction of translation of the forming surface on which the fibrous web segment shown has been formed. The fibrous web 50 has a top surface 51, a bottom surface 52, an end surface 56, and side surfaces 58. This web has sequential integral thickness layers, including a top layer 57 corresponding compositionally to sheet 13, a bottom layer 60 corresponding compositionally to sheet 12 and a transitional zone 59 of mixed composition, insofar as the concentrations of the respective materials of sheets 12 and 13 therein are concerned. Again, the boundary demarcated by transition zone 59 is comparatively small in reference to the thicknesses of the homogeneous constituent layers 57 and 60.

FIG. 6 representatively shows a perspective view of the end segment of another fibrous web laid employing the apparatus illustrated in FIG. 1, but moving the forming surface along the diagonal direction C. Sheets 12 and 13 are parallel fed into slot 11, and the fibrous formed web 70 has a top surface 72, a bottom surface 71 and side surfaces 73. The formed web has two generally discrete, laterally extending zones 74 and 75 having different compositions, and also has an interfacial zone or region 76 located therebetween. This interfacial zone is composed of fibers of both components which have been mixed and intermingled together. The edges of the laid fibrous web can have a lower basis weight than the remaining central portion of the web. The CD width of the lower basis edge portions will depend upon the diagonal orientation angle, "theta", and the "thickness" of the fiber stream being deposited onto the forming surface.

The multicomponent fibrous webs produced by the apparatus and method of the present invention may usefully be employed as absorbent articles in applications such as sanitary napkins or disposable diapers, as well as any other application area for fibrous webs wherein different homogeneous compositional zones are useful.

Although illustrative embodiments of the present invention have been shown and described herein, it will be appreciated that other embodiments, modifications and variants are possible, and all such apparent embodiments, modifications and variants are to be regarded as being within the spirit and scope of the present invention.

What is claimed is:

1. An apparatus for forming an integral laid fibrous web having multiple compositional therein, comprising: a cylindrical housing having in its outer cylindrical surface (i) longitudinally extending inlet means for introduction of fiberizable materials into said housing, said inlet means including a first inlet slot and

a second inlet slot, and (ii) a longitudinally extending exit means generally longitudinally coextensive with and circumferentially spaced from said inlet means, for discharge of fiberized materials from said housing;

a rotatable cylindrical body concentrically positioned in said housing for rotation therewith about its cylindrical axis and having a plurality of radially extending circumferentially spaced-apart blades on its outer cylindrical surface, said blades having a radial extent defining a first radial dimension, with said cylindrical body and cylindrical housing having an annular space therebetween defining a second radial dimension not substantially larger than said first radial dimension;

means for feeding a first fiberizable component to said first inlet slot;

means for feeding a second fiberizable component to said second inlet slot with said second fiberizable component positioned at least partially axially isolated from said first fiberizable component;

a translatable foraminous forming surface positioned for receipt of the fiberized materials discharged from said cylindrical housing through said exit means; and

drive means for rotating said rotatable cylindrical body in said cylindrical housing, at a rotational speed sufficient to substantially avoid lateral, axial interdispersion between said first and second components therein,

whereby the fiberized components discharged from said cylindrical housing onto said foraminous forming surface during translation thereof are laid thereon to form generally discrete homogeneous compositional zones constituted within the integral laid fibrous web.

2. Apparatus according to claim 1, further comprising means for combining the fiberized components discharged from the housing through said exit means with a merging air stream to yield an air-fibers stream, and for channeling said air-fibers stream onto said foraminous forming surface without substantial mixing thereof transverse to the direction of flow and said stream.

3. Apparatus according to claim 2, wherein said combining means comprises a flow housing the interior of which defines a flow channel in fibers flow communication with said discharge slot of said cylindrical housing.

4. Apparatus according to claim 1, wherein a single, longitudinally extending inlet slot comprises said inlet means for introduction of fiberizable materials into said housing, wherein said first fiberizable component feeding means feed same to a first longitudinal segment of said inlet slot, and said second fiberizable component feeding means feed same to a second longitudinal segment of said inlet slot distinct from said first longitudinal segment thereof.

5. An apparatus as recited in claim 1, wherein said exit means comprises said cylindrical housing having a curvilinear discharge opening formed therethrough.

6. An apparatus as recited in claim 1, wherein said drive means is capacitively sized to provide at the outer surface of said rotatable body a peripheral speed which is about 16,000-30,000 fpm.

7. An apparatus as recited in claim 1, wherein said blades have a radial height "r", said housing and said rotatable body define an annular radial dimension "g" therebetween, and wherein the ratio of "r" to "g" is in the range of about 0.7-0.98.

8. An apparatus as recited in claim 1, wherein said ratio of "r" to "g" is in the range of about 0.8-0.95.

9. An apparatus as recited in claim 1, wherein said exit means comprises an outer surface of said housing having a skewed, approximately helical discharge slot duct opening formed therein, said discharge slot duct oriented to face generally toward said foraminous forming surface.

10. An apparatus as recited in claim 1, wherein said foraminous forming surface is constructed to be translatable in a direction generally parallel to the axis of said rotatable body to produce discrete homogeneous compositional zones in a layered configuration within said laid fibrous web.

11. An apparatus as recited in claim 1, wherein said foraminous forming surface is constructed to be translatable in a direction generally perpendicular to the axis of said rotatable body to produce within said laid fibrous web an interfacial boundary area, which is composed of a fibrous mixture of said first and second components, and which is located between a first contiguous laterally extending zone composed of fibers of said first component and a second contiguous laterally extending zone composed of fibers of said second component.

12. An apparatus as recited in claim 1, wherein said foraminous forming surface is constructed to be translatable in a direction diagonal to the axis of said rotatable body to adjust a cross-directional width of an interface region of said laid fibrous web, said interface region comprising a fibrous mixture of said first and second fiberizable components, and said interface region located between a first laterally extending zone composed of said first fiberizable component and a second laterally extending zone composed of said second fiberizable component.

13. An apparatus as recited in claim 3, further comprising means for providing a flow of said merging air stream with a substantially uniform velocity profile across an inlet face of said flow housing.

14. An apparatus as recited in claim 3, further including means for providing a fiber stream of said fiberized components at a velocity which is substantially equal to, or greater than the velocity of said merging air stream, but not so great as to cause undesired recirculating gas flows within said flow housing.

15. An apparatus as recited in claim 1, wherein said second inlet slot is circumferentially spaced from said first inlet slot and at least partially overlaps said first inlet slot along the axial dimension of said rotatable body.

16. A method for forming an integral laid fibrous web having multiple compositional zones therein, comprising the steps of:

providing a housing having in its outer surface (i) inlet means for introduction of fiberizable materials into said housing and (ii) exit means generally laterally coextensive with and translationally spaced from said inlet means, for discharging fiberized materials from said housing, said lateral dimension extending along said housing in a longitudinal direction which is transverse to the direction of introduction of said fiberizable materials into said housing;

providing a translatable body positioned in said housing for movement therein and having a plurality of blades on its outer surface, with the outer surface of said translatable body and said housing having

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space therebetween wherein said blades travel during movement of said translatable body;
 translating a foraminous forming surface positioned for receipt of the fiberized materials discharged from the housing through said discharge means;
 feeding a first fiberizable component to said inlet means;
 feeding a second fiberizable component to said inlet means, at least partially laterally isolate from said first fiberizable component;
 translating said translatable body in said housing at a translational speed sufficient to substantially avoid lateral dispersion between the first and second components therein; and
 discharging fiberized material from the housing through said exit means onto said foraminous forming surface during translation thereof, whereby the fiberized components discharged from said housing onto said foraminous forming surface during translation thereof are laid thereon to form generally discrete homogeneous compositional zones of the integral laid fibrous web.

17. A method according to claim 16, further comprising the step of combining the fiberized components discharged from said cylindrical housing through said discharge means with a merging air stream to yield an air-fibers stream, and channeling said air-fibers stream onto said foraminous forming surface without substantial mixing thereof transverse to the direction of flow of said stream.

18. A method according to claim 17, further comprising confining said air-fibers stream in a flow channel in fibers flow communication with said exit means of said cylindrical housing.

19. A method for forming an integral laid fibrous web having multiple compositional zones therein comprising the steps of:

providing a cylindrical housing having in its outer cylindrical surface (i) longitudinally extending inlet means for introduction of fiberizable materials into said housing and (ii) a longitudinally extending exit means generally longitudinally coextensive with and circumferentially spaced from said inlet means, for discharge of fiberized materials from said housing;

providing a rotatable cylindrical body concentrically positioned in the housing for rotation therein about its cylindrical axis and having a plurality of radially extending, circumferentially spaced-apart blades on its outer cylindrical surface, said blades having a radial extent defining a first radial dimension, with said cylindrical body and cylindrical housing having an annular space therebetween defining a second radial dimension not substantially larger than said first radial dimension;

translating a foraminous forming surface positioned for receipt of the fiberized materials discharged

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from said cylindrical housing through said discharge means;
 feeding a first fiberizable component to said inlet means;

feeding a second fiberizable component to said inlet means, at least partially axially isolate from said first fiberizable component;

rotating the rotatable cylindrical body in the cylindrical housing at a rotational speed sufficient to substantially avoid lateral, axial interdispersion between the first and second components therein; and discharging fiberized materials from the cylindrical housing through said exit means onto said foraminous forming surface during movement thereof, whereby the fiberized components discharged from said cylindrical housing onto said foraminous forming surface during translation thereof are laid thereon to form generally discrete homogeneous compositional zones constituted within the integral laid fibrous web.

20. A method according to claim 19, wherein said foraminous forming surface is translated in a direction generally transverse to the cylindrical axis of said rotatable cylindrical body.

21. A method according to claim 19; wherein said foraminous forming surface is translated in a direction generally parallel with the cylindrical axis of said rotatable cylindrical body.

22. A method as recited in claim 19, wherein said foraminous forming surface is translated in a direction that is generally diagonal to the cylindrical axis of said rotatable cylindrical body.

23. A method according to claim 19, wherein a single longitudinally extending inlet slot comprises said inlet means in said cylindrical housing, the first fiberizable component is fed to a first longitudinal segment of said inlet slot and said second fiberizable component is fed to a second longitudinal segment of said inlet slot distinct from said first longitudinal segment thereof.

24. A method according to claim 19, wherein longitudinally extending, circumferentially spaced-apart inlet slots comprise said inlet means for introducing fiberizable materials into said housing; said first fiberizable component is fed to a first inlet slot and said second fiberizable component is fed to a second inlet slot.

25. A method as recited in claim 19, wherein said rotatable body is rotated to provide, at its outer surface, a peripheral speed of about 16,000-30,000 fpm.

26. A method as recited in claim 24, further comprising the steps of:

circumferentially spacing said second inlet slot from said first inlet slot; and

at least partially overlapping said first and second inlet slots along the axial dimension of said rotatable cylindrical body.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 4,767,586
DATED : August 30, 1988
INVENTOR(S) : F. Radwanski et al.

Page 1 of 3

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

IN THE CLAIMS:

Column 18, Claim 1, line 2, after the word "compositional", insert the word
-- zones --.

Column 19, Claim 2, line 43, delete "and" and substitute therefor --of--.

IN THE SPECIFICATION:

Column 1, line 48, delete "accomodate" and substitute therefor --
accommodate --.

Column 1, line 62, delete "ktherein" and substitute therefor --
therein --.

Column 2, line 11, delete "589" and substitute therefor -- 598 --.

Column 3, line 34, delete "if" and substitute therefor -- is --.

Column 4, line 48, delete "thichness" and substitute therefor --
thickness --.

Column 4, line 68, delete "for hearth" and substitute therefor --
forehearth --.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 4,767,586
DATED : August 30, 1988
INVENTOR(S) : F. Radwanski et al.

Page 2 of 3

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 5, line 47, delete "whicle" and substitute therefor -- while --.

Column 5, line 66, delete "randon" and substitute therefor -- random --.

Column 6, line 17, delete "continous" and substitute therefor -- continuous --.

Column 6, line 32, delete "it" and substitute therefor -- in --.

Column 7, line 40, delete "it" and substitute therefor -- et --.

Column 7, line 59, delete "homogemeous" and substitute therefor -- homogeneous --.

Column 8, line 53, delete "tras-latable" and substitute therefor -- translatable --.

Column 9, line 40, after the word "fiber" and before the word "the", insert -- of --.

Column 10, line 29, delete "circuferentially" and substitute therefor -- circumferentially --.

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 4,767,586
DATED : August 30, 1988
INVENTOR(S) : F. Radwanski et al.

Page 3 of 3

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 12, line 18, delete "components" and substitute therefor -- components --.

Column 12, line 40, after the word "shown" and before the word "the", insert -- , --.

Column 15, line 4, delete "discharte" and substitute therefor -- discharge --.

Column 16, line 44, delete "electircal" and substitute therefor -- electrical --.

Column 16, line 59, delete "pracitice" and substitute therefor -- practice --.

Column 16, line 67, delete "q" and substitute therefor -- g --.

Column 17, line 17, delete the word "the".

Column 18, line 4, delete "homogeous" and substitute therefor -- homogeneous --.

Column 18, line 45 - delete "thichness" and substitute therefor -- thickness --.

Signed and Sealed this
Seventeenth Day of October, 1989

Attest:

DONALD J. QUIGG

Attesting Officer

Commissioner of Patents and Trademarks

Appendix 9:
U.S. Pat. No. 4,411,787 by Riley

[54] **REVERSE OSMOSIS APPARATUS**

[75] Inventor: Robert L. Riley, San Diego, Calif.

[73] Assignee: UOP Inc., Des Plaines, Ill.

[21] Appl. No.: 400,786

[22] Filed: Jul. 22, 1982

[51] Int. Cl.³ B01D 31/00

[52] U.S. Cl. 210/321.5; 210/433.2

[58] Field of Search 210/321.1, 321.3, 433.2,
210/494, 321.5[56] **References Cited****U.S. PATENT DOCUMENTS**3,228,876 1/1966 Mahon 210/321.3 X
3,813,334 5/1974 Bray 210/321.1*Primary Examiner*—Frank A. Spear, Jr.

[57]

ABSTRACT

A reverse osmosis module in which the semipermeable membrane comprising a microporous support reinforced on one side thereof with a backing material and the other side thereof having deposited thereon an ultra-thin film formed by cross-linking polyethyleneimine with a cross-linking agent such as isophthaloyl chloride and the backing for the membrane sandwich comprising a film of a polyethylene-terephthalate positioned between two layers of an epoxy-impregnated polyester may be utilized to concentrate or dewater aqueous solutions at elevated temperatures and pressures. The module may be used at temperatures ranging from about 50° to about 95° C. and pressures ranging from 400 to about 1200 psi to dewater aqueous sugar solutions, salt solutions, starch solutions, etc.

5 Claims, No Drawings

REVERSE OSMOSIS APPARATUS

BACKGROUND OF THE INVENTION

Heretofore, various forms of apparatus have been used in a reverse osmosis separation process. Osmosis is a diffusion proceeding in which the diffusion proceeds through a semipermeable membrane, typically separating two solutions of unequal concentration, the osmosis tending to equalize the concentration of the solutes in each solution. The semipermeable membrane possesses a finite permeability for one component of a solution, for example, water, while remaining totally impermeable to another component in the solution such as, for example, sodium chloride. During the process of osmosis, pure water diffuses from a first solution having a lower solute concentration through the membrane into a second solution having a higher solute concentration.

It is possible to restrain diffusion of the pure water through the membrane by maintaining the second solution, which possesses the higher solute concentration, at an elevated pressure with respect to the pressure conditions of the first solution. The particular pressure at which diffusion through a semipermeable membrane into the second solution is substantially retarded or halted is known as the osmotic pressure. However, if the pressure applied to the second solution is further increased relative to that applied to the first solution such that osmotic pressure of the second solution is exceeded, reverse osmosis occurs. The particular pressure which is required to bring about reverse osmosis is generally dependent upon the composition of the particular solutions disposed on opposite sides of the semipermeable membrane. A particularly applicable operation of reverse osmosis is in the gas of sea water. For example, if a sea water is disposed on one side of an appropriate semipermeable membrane and a relatively pure water solution, or a gaseous atmosphere is present on the other side, reverse osmosis begins to occur when the sea water is subjected to a pressure of approximately 350 psi absolute. As a result of this reverse osmosis, pure water diffuses through the membrane from the sea water.

Certain types of apparatus which may be utilized for reverse osmosis applications such as desalinization of sea water, are known from such patents as U.S. Pat. Nos. 3,367,504, 3,386,583 and 3,417,870, among others. However, these patents utilize, as a backing material for semipermeable membranes which form a product water passageway, such materials as cotton, wool, graphite, cloth, silicon carbide grit or salt particles held together with a suitable binder, glass felt, or fibrous plastic material such as nylon, polyester, rayon, rayon viscose, acrylic fibers, etc.

As will hereinafter be shown in greater detail, a reverse osmosis apparatus has been prepared which will permit the use of such an element in a high temperature operation at relatively high applied pressures. The operability of this element is due to the use of certain composites which provide a novel arrangement of materials to form the product water-carrying channels.

BRIEF SUMMARY OF THE INVENTION

This invention relates to an improvement in an apparatus for purifying or concentrating a desired product into a process employing the apparatus. More specifically, the invention is concerned with an improved reverse osmosis apparatus and to a process utilizing this

apparatus whereby the aforesaid process may be effected at relatively high temperatures and applied pressures.

It has now been discovered that certain processes involving the concentration or dewatering of aqueous solutions containing a solute therein is advantageously effected at relatively high temperatures. By employing high temperatures in dewatering operations such as the dewatering of aqueous solutions containing sugar, it is possible to retard or substantially halt the growth of any bacteria which may be present in the aqueous solution. In addition, by dewatering the sugar solution at a relatively high temperature within the range hereinafter set forth in greater detail, it is also possible, upon recovery of the concentrated or dewatered solution, to allow the sugar to crystallize out and be recovered upon the solution reaching room temperature. In addition to utilizing the process and apparatus of the present invention to dewater sugar, it is also contemplated that aqueous solutions containing other solutes such as salt, organic or inorganic chemicals, dairy products, maple syrup, starches, etc. may also be concentrated or dewatered utilizing the process and apparatus thereof.

It is therefore an object of this invention to provide an improved reverse osmosis apparatus utilizing certain composite materials as a backing for the semipermeable membranes contained therein.

A further object of this invention is found in an improved process and apparatus for concentrating or dewatering an aqueous solution containing a solute dissolved therein by operating the process at an elevated temperature and pressure.

In one aspect, an embodiment of this invention resides in an apparatus for recovery by reverse osmosis of a desired product from an aqueous solution comprising a hollow mandrel having axial passageway means provided therein, a layer of first porous backing material adjacent to and surrounding said mandrel, a plurality of generally laterally coextensive leaves of porous backing material in contact with and extending generally radially outward from said first backing material, said leaves having at least one edge thereof in a generally parallel relationship to the longitudinal axis of said mandrel, a plurality of semipermeable membrane sheets, each having a fold line therein, said fold line being positioned in contact with said first porous backing material in a generally parallel relationship to the longitudinal axis of said mandrel, and each positioned between two of said leaves of porous backing material, a plurality of separator grid-sheets each positioned within the folds of said membranes to form a fluid conducting passageway within each of said folds, said pluralities of porous backing material, membranes and separator grids being spirally wound around said first backing material in overlapping relationship upon one another to form a roll comprising multiple layers of porous backing material-membrane-fluid conducting passageway-membrane groupings, means to supply said fluid to one end of said fluid conducting passageway, means to withdraw fluid from the opposite end of said passageway, and means to withdraw fluid from said hollow mandrel, the improvement comprising utilizing as a backing material for said semipermeable membranes a composite consisting of a film of a polyethylene terephthalate positioned between two layers of an epoxy-impregnated polyester, said composite forming a product-water carrying channel.

Another embodiment of this invention resides in a method for concentrating an aqueous solution containing dissolved solute therein which comprises passing said solution through the apparatus of claim 1 at concentration conditions, and recovering the resultant concentrated solution.

A specific embodiment of this invention is found in an apparatus for recovery by reverse osmosis of the desired product from an aqueous solution in which the backing material comprising a composite consisting of a polyethylene terephthalate positioned between two layers of an epoxy-impregnated polyester has been treated at a temperature in the range of from about 100° to about 150° C. in an air atmosphere prior to use thereof.

Another specific embodiment of this invention is found in a method for concentrating an aqueous solution containing sugar in which said solution is passed through the improved apparatus of the present invention at a pressure in the range of from about 400 to about 1200 psi and a temperature in the range of from about 50° to about 95° C., and recovering the resultant concentrated solution.

Other objects and embodiments will be found in the following further detailed description of the invention.

DETAILED DESCRIPTION OF THE INVENTION

As hereinbefore set forth, the present invention is concerned with an improved reverse osmosis apparatus and to a process for effecting the concentration or dewatering of aqueous solutions at relatively high temperatures. The apparatus of the present invention is similar in nature to that described in U.S. Pat. No. 3,417,870 and comprises a multi-leaf membrane module, a pressure-tight enclosure for containing the module, and a product water take-off assembly. The module will include a central hollow mandrel which also serves as the product water collection means or take-off tube. A plurality of membrane sandwiches are interleaved between a corresponding number of strips of backing material of the type hereinafter set forth in greater detail which will enable the apparatus to be used at the relatively high operating temperatures of the present process, said backing material being bonded to the mandrel. The membrane sandwiches comprise a sheet of semipermeable membrane material of the type hereinafter set forth in greater detail folded back upon itself and a strip of separator grid material which is disposed intermediate each of the respective folds. The membrane sandwiches are disposed about the mandrel in an equally spaced relationship with each other to spirally wind the sandwich and the backing material tightly about the mandrel. In fabricating the membrane module, one end of the sheet of backing material comprising a composite of a type suitable for use as a product water-carrying channel is initially tightly wound about substantially the entire circumferential surface of the mandrel, the opposite end of the sheet extending radially from the mandrel for a predetermined distance. The membrane sandwich which, as hereinbefore set forth, comprises the folded sheet of membrane material and the strip of separator grid material is disposed adjacent the radially extending portion of the sheet of backing material such that its closed end, the fold line of the sheet of membrane material, is in contact with a portion of the backing material which is wound around the mandrel and its fold is adjacent the radially extending portion of the backing mate-

rial. The mandrel is preferably rotated a predetermined angular distance so that the fold of the sandwich contacts the backing sheet. A fluid-tight seal is provided along the outer edges of the area of contact between the fold of the sandwich and the radially extending portion of the backing material by use of a suitable adhesive at these regions. This enables the backing material to be sealed from communication from solution which has not initially passed through the membrane material and, in addition, also serves to provide a passageway through the backing material for the product water.

One end of the sheet of backing material of one membrane sandwich is disposed on contact with a portion of the backing material of an adjacent membrane sandwich wound about the surface of the mandrel, the other end of the sheet of the first backing material extending radially outward therefrom. A sheet of the backing material is then placed in contact with a fold of the membrane sandwich, thus providing a fluid-tight seal between the backing material and the fold which is similar to that provided between the fold and backing material of the adjacent membrane sandwich and sealed. The action is repeated with the various membrane sandwiches in order to suitably bond a desired number of sandwich leaves, and wound about the mandrel to form a roll. After completing the bonding of the sandwich leaves and winding the same in a leafed configuration which is wound around the mandrel, a layer of bonding material is applied along the outer edges of each of the strips of the backing material to define the product water channel or passageway within the product water backing material, and precludes communication of the backing material with the solution which is not passed through the membranes and which is introduced into the area adjacent to the edges of the wrapped module.

The backing material which is utilized in the apparatus to allow a reverse osmosis process employing relatively high temperatures and applied pressures comprises a composite which consists of a dense film of a polyethylene terephthalate positioned between two layers of an epoxy-impregnated polyester. In the preferred embodiment of the invention, the epoxy-impregnated polyester comprises a product known generally as tricot. The tricot possesses a smooth, dense surface on one face thereof, while the other surface thereof contains channels or grooves. The backing material for the apparatus of the present invention consists of the two layers of the aforementioned tricot material separated by a thin film of polyethylene terephthalate, the thickness of said polyethylene terephthalate being in a range of from about 1 to about 10 mils. The upper channels of the tricot are placed next to the film, while the smooth, dense surfaces of the epoxy-impregnated tricot polyester contact the semipermeable membrane. It has now been discovered that by treating the backing material comprising the composite of polyethylene terephthalate positioned between two layers of epoxy-impregnated polyester at a relative temperature in the range of from about 100° to about 150° C. in an air atmosphere for a period of time ranging from about 0.5 to about 4 hours or more prior to incorporation into the module, it is possible to provide a product water channel in which the flow resistance in the channel at higher temperature and pressure is minimized. It is necessary to use this composite for the backing material which acts as a product water-carrying channel in the form thus described inasmuch as if only one layer of the epoxy-impregnated polyester were used, intrusion of the mem-

brane by the polyester would occur and thus a less efficient transport of product water would occur. The particular configuration of the backing material acts to support each membrane and thus results in a more efficient water transport at elevated temperatures and pressures.

The semipermeable membrane material which is utilized in the module of the present invention comprises a microporous support reinforced on one side thereof by a backing and containing on the other surface thereof, a thin film. The microporous substrate may be selected from various commercially available materials such as Millipore filters or the microporous support may be cast from homopolymers or mixed polymers of cellulose acetate, cellulose nitrate, cellulose butyrate, polysulfone, polystyrene, etc. The microporous support as hereinbefore set forth will be reinforced by the addition of a backing such as a fabric which may be naturally occurring or synthetic in origin such as cotton, wool, linen, dacron, nylon, orlon, rayon, etc. The thin film which is in contact with the other side of the microporous support comprises, in the preferred embodiment of the invention, a polymer formed by the cross-linking of polyethyleneimine with a cross-linking agent such as acid chlorides including formyl chloride, acetyl chloride, propionyl chloride, butyl chloride, susinyl chloride, isophthaloyl chloride, ethylenediisocyanate, benzenediisocyanate, toluenediisocyanate, etc.

The semipermeable membrane may be formed by forming a wet continuous film on the surface of the microporous support by soaking the support in a solution of the polyethyleneimine following which the support is recovered, dried, and thereafter contacted with a solution of the cross-linking agent. After contacting the coated support with the cross-linking agent to effect a cross-linking and formation of an ultra-thin film, the composite semipermeable membrane may then be dried in air and drawn through means at an elevated temperature to further effect the drying, said means including radiant gas heaters, infra-red lamps, etc.

The mandrel which serves as a product water collection means is generally in the form of a hollow tubular member which may be provided with a plurality of slots or apertures on the outer circumference thereof. The slots or apertures must be within the region encompassed by the adhesive which binds the composite backing material to the mandrel. In the preferred embodiment, the mandrel comprises a relatively corrosion-resistant material, inasmuch as it is generally disposed in a relatively moist environment. As was hereinbefore set forth, one end of the backing material is wound about substantially the entire outer circumference of the mandrel while the other sheets of backing material are disposed in contact with the initial winding. By placing the composite backing material in such a position, a fluid communication is established between the slots or apertures in the mandrel and the product water carried by the composite backing material. This provision therefore permits the product water to flow into the hollow interior of the mandrel from which it may be removed.

The pressure-tight enclosure in which the module is positioned consists of a corrosion-resistant material such as copper, stainless steel, mold steel, fiberglass-reinforced epoxy, etc. and usually comprises a cylindrical outer shell having a cap secured to the upper end and a flange secured to the lower end, the cap and flange being secured to the shell by conventional means such as brazing, welding, etc. In addition, the enclosure is

provided with a feed inlet pipe and outlet pipe. In the preferred embodiment, the internal diameter of the enclosure approximates the outer diameter of the module to provide a sufficiently tight fit between the module and the enclosure, thus obviating the need for further seals.

The process for dewatering or concentrating an aqueous solution containing a solute such as sugar, starch, salt, etc. is effected at elevated temperatures and pressures. The ability to effect the dewatering of the solution at elevated temperatures is due, as hereinbefore set forth, to the employment of the composite backing material of the type hereinbefore set forth in greater detail. Operating conditions which are employed for the dewatering of the solution include a temperature in the range of from 50° to about 95° C. and a pressure in the range of from about 400 to about 1200 psi absolute. In addition to these operating conditions, the concentration of the solute in the solution may range up to about 30% by weight of the solution. The process is effected by charging the aqueous solution to the unit at the aforesaid pressure sufficient to cause reverse osmosis, that is, to cause diffusion of product water from the aqueous solution through the semipermeable membranes into the composite backing material. The substantially purified product water generally diffuses through the folds of the semipermeable membrane comprising a thin film composite of the type hereinbefore set forth in greater detail which comprises each of the sandwiches as the aqueous solution containing the solute flows through the passageways defined in each of the sandwiches between separator grid material. The product water diffuses through the channels of the composite backing material which are formed on three sides by the epoxy-impregnated polyester and the fourth side by the thin film polyethylene terephthalate, said composite backing material being disposed intermediate the respective folds of the adjoining membrane sandwiches and thereupon flows through the channels of the backing material until it reaches the portion of the backing material which is wound around the mandrel. At this point, the product water flows into the hollow interior of the mandrel through the slots of apertures which are positioned about the outer circumferential surfaces of the mandrel. Upon leaving the hollow interior of the mandrel, the product water flows through the open end of the mandrel, through the take-off assembly and thence through the product water outlet pipe. The concentrated or dewatered aqueous solution is also recovered from the unit through an outlet pipe.

While the above discussion has illustrated the process utilizing one element or module, it is also possible that a plurality of elements or modules which are constructed in a similar manner may be employed. The similar elements or modules are suitably interconnected at their respective inlet pipes and with appropriate heat connections and their respective outlet pipes, thereby forming a dewatering or concentration apparatus which may be adapted for providing substantial quantities of the concentrated aqueous solution on a commercial scale.

The following examples are given for purposes of illustrating the present process. However, it is to be understood that these examples are merely illustrative in nature and that the present invention is not necessarily limited thereto.

EXAMPLE I

In this example, an aqueous sugar solution which was obtained by the treatment of sugar beets was subjected to a dewatering process. Six modules which were constructed in accordance with the description set forth in the specification in which the thin film semipermeable membrane comprised a polyamide prepared by cross-linking a polyethyleneimine with isophthaloyl chloride on a polysulfone support which was reinforced with a non-woven polyester backing, were linked in series. In accordance with the present invention, the backing material for the semipermeable membrane sandwich comprised a composite consisting of a thin film of a polyethylene terephthalate sandwiched between two layers of an epoxy-impregnated polyester known in the trade as tricot. Each module contains 50 square feet of membrane area. The feedstock which contains from 100 to 150 grams per liter of sugar was fed to the modules at a temperature ranging from 78° to 80° C. and pressures ranging from 420 to 740 pounds per square inch (psi), the pH of the feed being maintained in a range of from 7.0 to 8.4. The feed was charged to the units at a rate of 7.75 gal/min, while 5.5 gal/min of concentrate and 2.25 gal/min of purified water was recovered. The results of this test are set forth in Table I below:

TABLE I

Hours on Stream	Feed		Concentrate		Permeate Rejection %	Recovery %
	Pressure psi	Sugar Cont. g/l	Sugar Cont. g/l	ΔP psi		
Start	500	103.8	185.9	25.0	99.83	29.0
3	550	111.4	174.7	26.0	99.88	29.0
25	695	146.3	211.5	21.5	99.94	29.0
27	720	107.1	199.9	23.0	99.93	29.0
30.5	650	137.6	202.2	21.0	99.91	29.0
35.5	740	142.1	206.9	24.0	99.89	29.0
37.5	420	126.7	179.2	24.0	99.91	29.0
54	630	126.7	181.5	25.5	99.91	29.0
73.5	610	123.4	189.5	25.0	99.94	29.0
93	570	111.4	175.8	—	99.07	29.0

It is apparent from the above table that a reverse osmosis module which was constructed so that the thin film semipermeable membrane comprised a polyamide and the backing material comprised a thin film of a polyethylene terephthalate sandwiched between two layers of an epoxy-impregnated polyester was able to concentrate or dewater a sugar solution at an elevated temperature and pressure greater than that which is commonly used in a reverse osmosis process. In addition, the module was able to operate at an efficient rate for a relatively long period of time, the permeate rejection being greater than 99% in all instances with a corresponding steady recovery rate.

EXAMPLE II

In a manner similar to that set forth in Example I above, a reverse osmosis apparatus or module may be

employed to concentrate or dewater a hot brine solution in which the brine solution is charged to the module at a temperature of about 95° C. and a pressure greater than about 400 psi. Likewise, the module or plurality of modules which are connected in series may also be employed to concentrate a starch solution in which the feed is charged to the modules at a temperature up to about 95° C. and a pressure up to about 1200 psi.

I claim as my invention:

1. An apparatus for recovery by reverse osmosis of a desired product from an aqueous solution which comprises a hollow mandrel having axial passageway means provided therein, a layer of first porous backing material adjacent to and surrounding said mandrel, a plurality of generally laterally coextensive leaves of porous backing material in contact with and extending generally radially outward from said first backing material, said leaves having at least one edge thereof in a generally parallel relationship to the longitudinal axis of said mandrel, a plurality of semipermeable membrane sheets each having a fold line therein, said fold line being positioned in contact with said first porous backing material in a generally parallel relationship to the longitudinal axis of said mandrel, and each positioned between two of said leaves of porous backing material, a plurality of separator grid sheets each positioned within the folds of said membranes to form a fluid-conducting passageway within each of said folds, said pluralities of porous backing material, membranes and separator grids being spirally wound around said first backing material in overlapping relationship upon one another to form a roll comprising multiple layers of porous backing material-membrane-fluid-conducting passageway-membranes groupings, means to supply said fluid to one end of said fluid-conducting passageway, means to withdraw fluid from the opposite end of said passageway, and means to withdraw fluid from said hollow mandrel, wherein a backing material for said semipermeable membranes composite consists of a film of a polyethylene terephthalate having a thickness in the range of about 1 mil to about 10 mil and which is positioned between two layers of an epoxy-impregnated polyester, said composite forming a product-water carrying channel.

2. The apparatus as set forth in claim 1 in which said semipermeable membrane comprises a microporous support reinforced on one side thereof with a backing, the other side thereof having deposited thereon an ultra-thin film formed by cross-linking polyethyleneimine with a cross-linking agent.

3. The apparatus as set forth in claim 2 in which said cross-linking agent is isophthaloyl chloride.

4. The apparatus as set forth in claim 2 in which said microporous support is polysulfone.

5. The apparatus as set forth in claim 2 in which said backing is a non-woven polyester.

Appendix 10:
U.S. Pat. No. 3,958,578 by Tennant

[54] ANTI-PRONATING DEVICE

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 165,666, July 23,
1971, abandoned.

[52] U.S. Cl. 128/585; 128/80 R;
272/96

[51] Int. Cl.² A61F 5/14

[58] Field of Search 272/57 D, 80; 128/583,
128/584, 585, 610, 80 R, 80 J; 36/2.5 A, 2.5
Y

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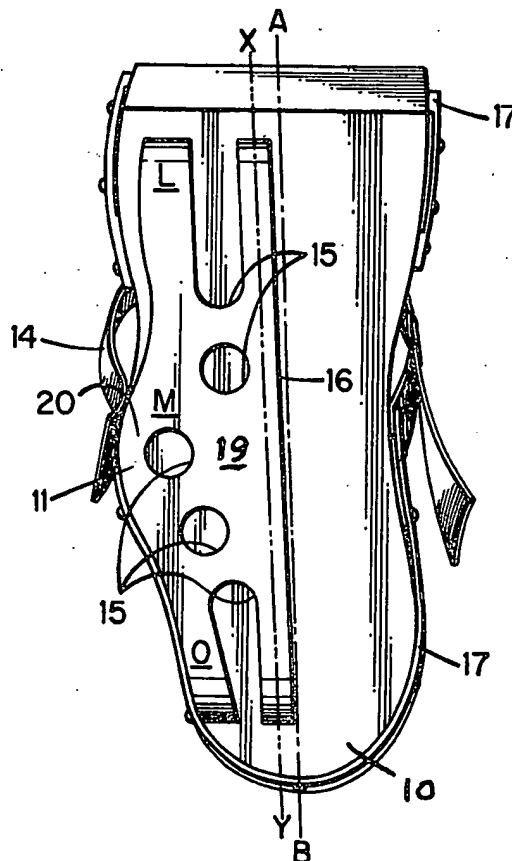
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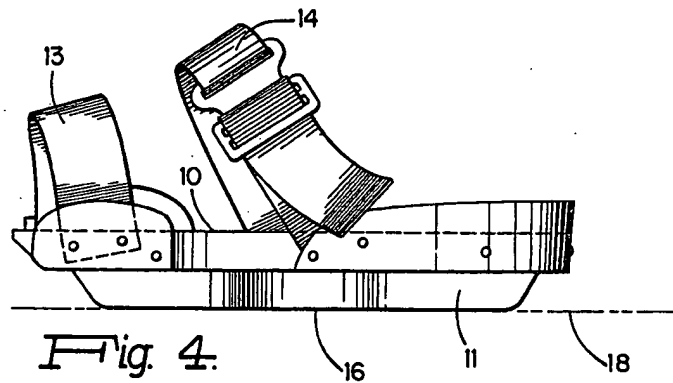
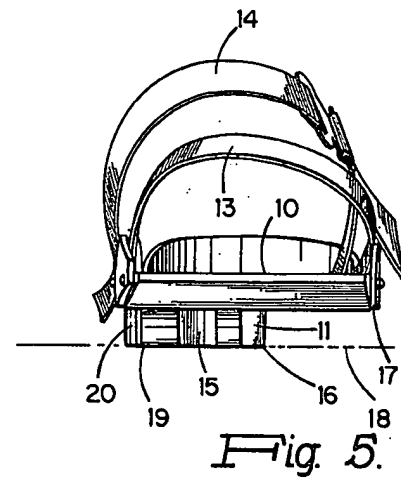
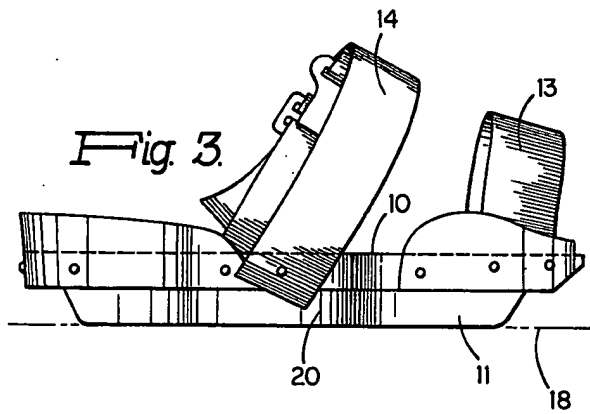
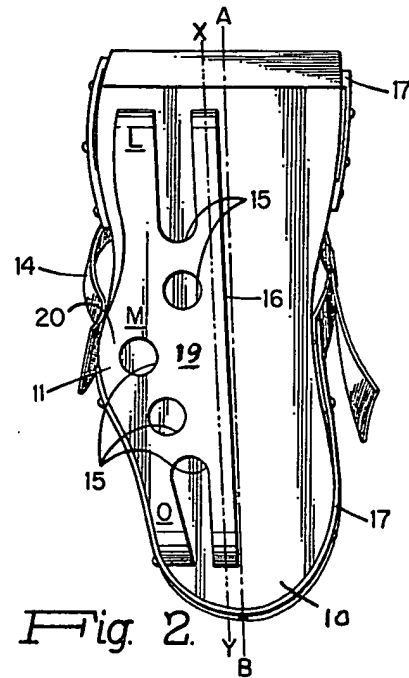
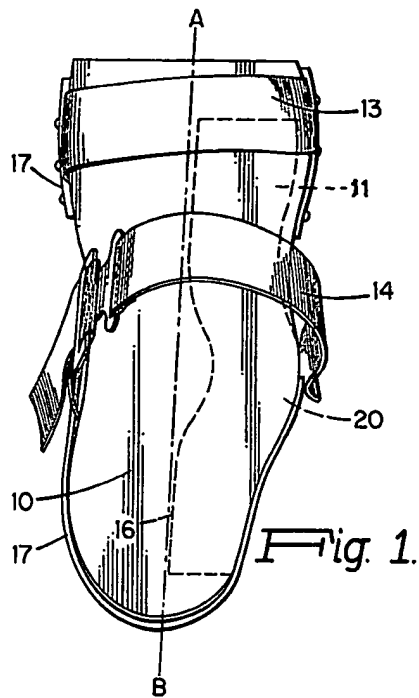
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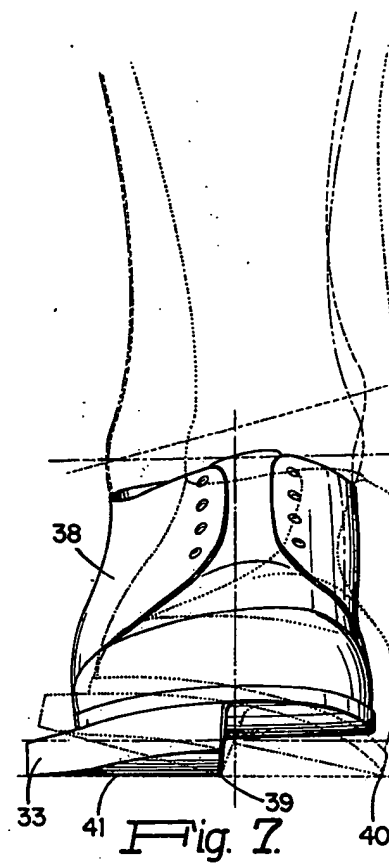
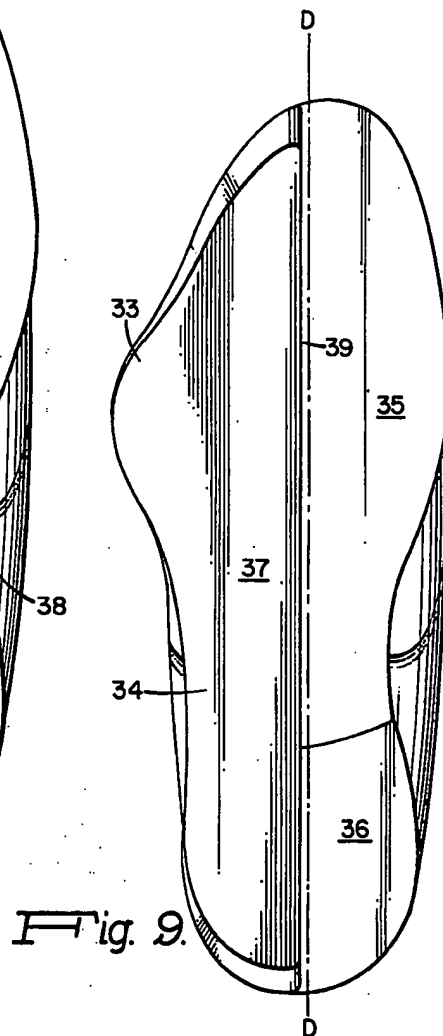
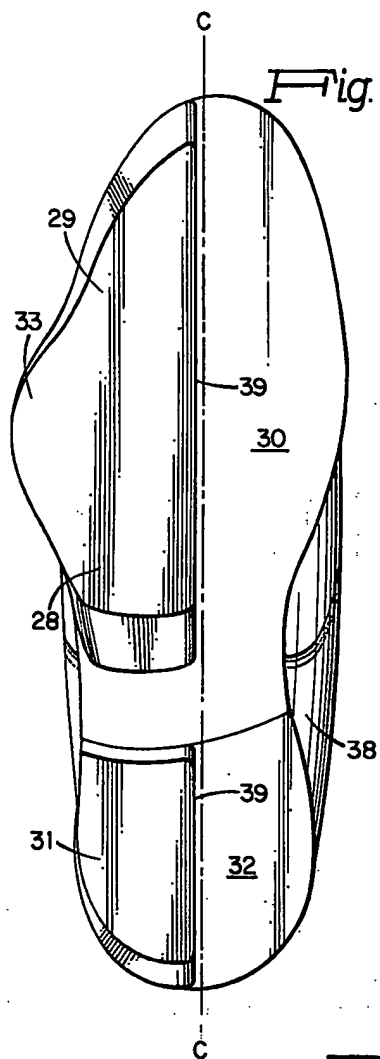
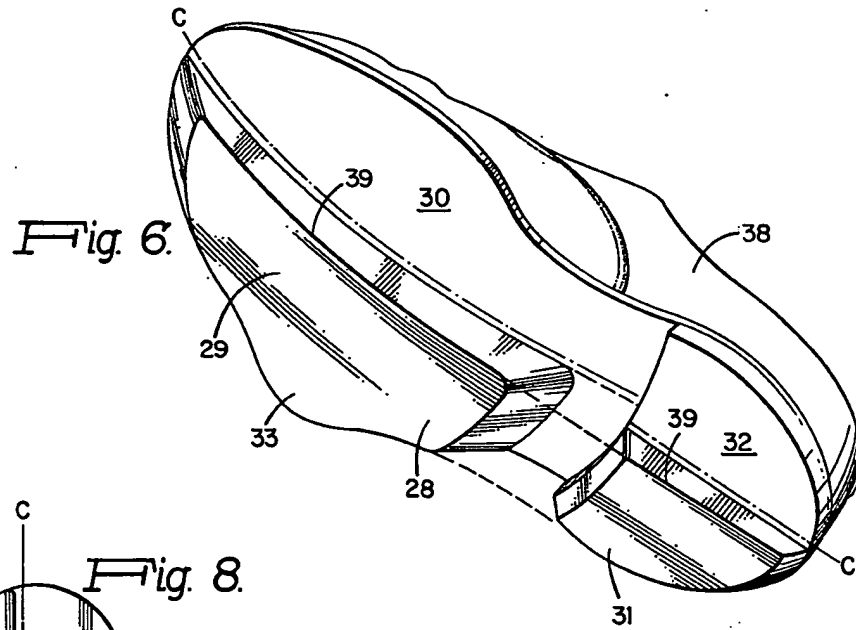
ABSTRACT

The invention is an article of manufacture in the form of specially shaped weight bearing units which are placed under the outer part of the user's feet. The units may be removably or permanently secured to the user's shoes. Through the use of the invention, the foot muscles can be developed and strengthened to overcome so-called flat feet caused by fallen arches.

8 Claims, 9 Drawing Figures







ANTI-PRONATING DEVICE**RELATED APPLICATIONS**

This application is a continuation-in-part of the application of Ross A. Tennant, Ser. No. 165,666 filed July 23, 1971 for Anti-pronating Device, now abandoned.

FIELD OF THE INVENTION

This invention relates to an exercising or training device and more particularly relates to a foot-attached exercising device which is useful in overcoming the problem relating to pronation, i.e., weak arches in persons of all ages.

Pronation is generally recognized as a condition of the foot whereby the muscles which normally maintain the arch of the foot in its typically raised position do not satisfactorily perform this function, thus resulting in a so-called weak or flat-footed condition. Most prior art corrective treatment of pronation is directed to arch padding and arch supports of one form or another in the attempt to hold the arch in a raised position on the theory of strengthening muscles ordinarily involved in the movement of inversion. By far the most prevalent of the prior art exercises which is prescribed is picking up marbles, or other similar objects, with the toes. These exercises, however, do little or nothing to correct the pronation condition. Other prior art attempts at correcting pronation include placing wedges at selected locations on the soles of the shoes.

SUMMARY OF THE INVENTION

The anti-pronation device disclosed herein is to be regarded as an exerciser to be worn as a removable attachment on the underside of each of the shoes of the user, as an attachment in the nature of a sandal to be secured to the foot or as units to be secured directly to the soles of the user's shoes. This is a training device and should be worn during designated training periods only. Thus my invention improves upon the prior art deficiencies by providing an anti-pronation device in the nature of a clog having an off-centered longitudinally extending relatively thick bar portion beneath the outer half of the user's foot. This clog may be attached to the shoe of a wearer or, alternatively, may be worn directly on the foot. Because of the off-centered location of the longitudinal bar, the wearer's foot has a tendency to tilt or bend inwardly into an acknowledged position of pronation or eversion. In an effort, however, to raise the inside of the clog to horizontal, the wearer must utilize the muscles involved in the elevation of his inner arch to force the weight to the outer weight bearing area of the foot, thus exercising and training the very muscles used in the movement of inversion.

It is accordingly an object of this invention to provide an exercising and training device which can be attached directly to a user's foot or can be permanently or removably attached to the under side of the user's shoe.

Another object of this invention is to provide a foot attached or shoe attached device which when worn in a prescribed manner will train inverter muscles which have the ability to invert, but have not been functioning in this capacity, so as to correct a weak arch condition.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a top plan view of one form of my anti-pronation exerciser which is removably attached to the user's shoe.

FIG. 2 is a bottom plan view of FIG. 1;

FIG. 3 is a right hand side elevation view of the anti-pronation device shown in FIG. 1;

FIG. 4 is a left hand side elevation view of FIG. 1;

FIG. 5 is a front elevation view of the device shown in FIG. 1.

FIG. 6 shows a modification in perspective in which the device of the invention is made in two parts and permanently attached to the sole and heel of the user's shoe.

FIG. 7 is a front elevation of the construction shown in FIG. 6 with the shoe being maintained in horizontal position by use of the foot, ankle and leg muscles.

FIG. 8 is a bottom plan view of FIGS. 6 and 7.

FIG. 9 is a bottom plan view of another modification in which the device is in the form of a single unit permanently attached to the sole of the user's shoe.

DETAILED DESCRIPTIONS OF THE INVENTION

The theory of principle of the herein disclosed invention is based on muscle education or re-education, i.e., training the adult or child to use his muscles to maintain the foot in a normal position. Normal weight bearing on the bottom of a foot does not occur from the heel to the head of the first metatarsal and head of the fifth metatarsal as is often interpreted but rather from the heel, along the outer border of the foot and across the ball, i.e., the calcaneus, the cuboid, base of the fifth metatarsal and the under portion of the metatarsal heads. However, in pronation or eversion, (the flat-foot condition), the weight bearing occurs along a path from the heel to the area of the first and second metatarsal heads with little or no weight carried along the normal outer border weight bearing area of the foot.

Inversion or supination is the act of raising the inner arch and forcing the weight bearing through its normal course. Muscles involved in this are called inverters and those primarily involved are specifically the tibialis posterior with accessory aid from flexor digitorum longus, flexor hallucis longus, and tibialis anterior. With the inner longitudinal arch inverted, the peroneus longus has a tightening effect on the tarsal region and in conjunction with other lateral muscles is important to maintaining a person's balance.

The tibialis posterior is by far the most effective inverter with the others being accessories in this movement. In all cases, inversion is only one of two or three movements in which each muscle is involved.

A person pronating, (i.e., with flat feet), knows only one way to stand and walk, and that is with the inner arch in a relaxed and flattened position, usually to the limits of the outer rotation or eversion. The prior art teaches the use of arch pads attempting through the application of pressure on the arch to prevent it from lowering — but the person still knows only one way to stand and, consequently, endures the pressure until he becomes accustomed to it. To correct the flat-foot condition, inversion is desired in order that the weight of the person may be carried along and through the normal weight bearing areas along the outer margin of the foot, thus influencing the alignment of the leg and thigh which has a tendency to rotate inward with the pronated foot. Though the muscles necessary to ac-

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compish this inversion are present, since they have never been utilized to perform their function as inverters, there should preferably be a training period, first to teach the person how to raise his arch with his own muscular effort and, secondly, to walk while still maintaining the arch in its muscularly raised position.

As can be seen in the drawings, the balance bar 11 in FIGS. 1 to 5, 28 in FIGS. 6 and 8 and 34 in FIG. 9, is off-centered to the outside of the longitudinal axis. In an unsupported position, and with the balance bar in contact with the floor, the top surface on which the user's foot is pressing is tilted or canted inwardly, as indicated by the dotted line position in FIG. 7, so that it approximates the plane of the undersurface of the foot in pronation. Thus, when the device is securely attached to a user's foot, the only way the top and bottom surfaces of the device can be brought to a laterally level or horizontal plane is by inverting the arch to force the weight to the outer margin of the foot and this can only be accomplished by muscular effort with the use of the inverters.

Referring now with greater particularity to the drawings, there is shown in FIGS. 1-5 one form of anti-pronation device or clog for attachment to each shoe or foot of a wearer. This clog is generally comprised of a rigid base 10 with an irregularly shaped balance bar or runner 11 on one side of the underportion thereof. Since this clog is worn on either the foot directly or, alternatively, over the shoe, there is both a vamp strap 13 over the vamp area and an instep strap 14 over the instep area below the ankle joint. These strap members may be made of an elastic material or other suitable strapping having an adjustable strap and buckle arrangement.

Balance bar 11 of suitable length and width in relation to base 10 is located on the outer side of line A-B of FIGS. 1 and 2 extending from the heel area (or from a variable point forward of the back of the heel), to some point in the general area of the metatarsal heads or ball area of the foot. In the preferred embodiment, the balance bar 11 will be approximately 5/8 inch thick but may vary with the overall size of the device.

It will be appreciated that the unit shown in FIGS. 1 to 5 is designed for attachment to the user's right foot. A similar complementary unit is available for attachment to the left foot, but the following description will apply to the right foot unit only, it being understood that the left foot unit will behave in the same manner but in the reverse direction.

When the user is standing on the unit 10 as viewed in FIG. 5 and is making no effort to hold his ankle in proper position, the unit will rotate about the edge 16 until the inner edge 17 of base 10 touches the floor at the point 18. In this position, the user's ankle is pronated substantially outwardly and the foot is in a position approximating the so-called flat-foot condition.

In order to bring the shoe and foot back to correct horizontal position, the user must make a conscious physical effort to rotate his foot inwardly. In so doing the base will be rotated counterclockwise as viewed in FIG. 5 about edge 16. Rotation will, of course, stop as soon as the bottom surface 19 of the balance bar engages the floor. In order to hold the base and balance bar in this horizontal position as the user stands thereon, a continuous force must be exerted by the muscles controlling this inward rotation of the foot. It is this muscular effort repeated at intervals during the day and for a short period of weeks thereafter that will

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strengthen the pertinent ankle and leg muscles sufficiently to overcome the flat-foot condition and to enable the person thereafter to walk properly on the outside of his foot.

In order to prevent the user from going beyond the proper horizontal position as he rotates his foot inwardly, the balance bar 11 has a lateral projection 20 extending a substantial distance outwardly beyond the outer side of the user's foot. This acts as a lever to block further counterclockwise rotation of the balance bar as viewed in FIG. 5 beyond the horizontal. Then the user knows when his ankles and feet are in correct position both when standing still or walking on the balance bars which are then carrying his full weight.

The illustrated embodiment in FIG. 2 shows a slightly modified balance bar 11 having the same exterior configuration, differing only in that it is perforated or recessed with cut-outs 15 for weight saving reasons, and also for providing better contact with rug type floor coverings whereby the rug nap enters these cut-outs and thus tends to prevent slipping. The remaining surface area indicated at L, M and O is adequate for support. It is, of course, to be understood that the entire floor contacting surface of balance bar 11 may be covered with a skid-resistant coating. Balance bar 11 may be removably connected to base 10, or, alternatively, the entire combination may be manufactured as an integral unit. It is to be further understood that in lieu of the balance bar, other means may be employed to provide the unbalance contemplated by this disclosure, as, for example, a plurality of small pegs or other protuberances may be attached to the under portion of base 10, or suitably attached to the sole portion of a wearer's shoes for that matter.

Modifications of the invention are shown in FIGS. 6, 7, 8 and 9. These constructions are the same in principle as those shown in FIGS. 1 to 5, differing only in that the balance bars are permanently secured to the user's shoes. This is often of economic advantage with children as the balance bars may be attached by nailing or gluing to a worn pair of shoes about to be discarded. Since the required muscular training period is usually not more than a few weeks at most, the child will ordinarily not outgrow the shoes before he has overcome his flat-foot condition. If necessary, the balance bars can be detached and used again on other shoes.

In FIGS. 6 and 8, the balance bar 28 is made in two pieces, one piece 29 being under the shoe sole 30 and the other piece 31 being under the heel 32. Both pieces are attached outward of the line C-C that defines the approximate center line of the foot.

The balance bar 29 has a lateral extension 33 similar to extension 20 shown in FIGS. 1, 2 and 5, for preventing outward rollover beyond the horizontal.

In order to provide a correct walking surface, the sole piece 29 is thicker than the heel piece 31.

In the construction shown in FIG. 9, the balance bar 34 is made of a single piece of material and preferably shaped to fit against the shoe sole 35 and heel 36 in a manner to provide a proper continuous walking bottom surface 37.

The balance bar 34 is located to the outside of the approximate center line D-D of the foot. The behavior of this construction with respect to pronation of the foot and ankle is the same as that found in FIGS. 1 to 5 and FIGS. 6 and 8.

The front elevation view in FIG. 7 is illustrative in the dotted line position of the manner in which the foot

rolls outward when the user stands on the balance bar without using his ankle muscles. The shoe 38 is being supported on the balance bar edge 39 and the inner edge 40 of the shoe sole. The solid line position is that which results when the user by muscular effort rotates the balance bar about edge 39 to bring the bottom 41 of the balance bar against the floor. The lateral extension 33 prevents outward rollover.

It should now be apparent in light of the foregoing description that I have provided a foot-attached exercising device which is useful in overcoming problems relating to pronation, i.e., weak arches and resulting flat feet.

The particular embodiments of the invention herein chosen for illustration and description are exemplary only, and it will, accordingly, be understood that various changes in the details, materials, and arrangements of parts herein described and illustrated may be made by those skilled in the art within the principles and scope of the invention as expressed in the appended claims.

I claim:

1. An anti-pronation exercising device adapted to be secured to a user's foot, said device comprising a base portion adapted to lie generally coextensive laterally with the width of the user's foot and coextensive longitudinally from the heel to at least the ball of the user's foot and having upper and lower surfaces;

a balance bar mounted on the said lower surface of said base portion and positioned to the outside of the centered longitudinal axis of the said base portion;

the said balance bar having a bottom weight supporting surface which has a longitudinally extending inner edge substantially aligned with said longitudinal axis and about which edge said device may pivot as the user's foot is pronated while standing thereon;

and means for attaching said device firmly in relation to the sole of the user's foot.

2. The construction set forth in claim 1, said balance bar having a plurality of recesses adapted to receive

and accommodate portions of a resilient surface which said user may be walking on.

3. The construction set forth in claim 1, said balance bar having a weight bearing portion thereof extending laterally beyond the outside front to rear boundary of the user's foot, whereby the ability of the user to rotate his foot inwardly beyond the horizontal when standing on said balance bar will be substantially diminished.

4. The construction set forth in claim 1, said base portion being in the form of a rigid pad adapted to fit against and be secured to the sole of the user's shoe.

5. The construction set forth in claim 1, said base portion comprising part of a shoe of a size adapted to fit the user's foot.

6. The construction set forth in claim 5, said balance bar being formed in a single unit attached to the sole and heel of said shoe.

7. The construction set forth in claim 5, said balance bar being formed of two pieces, one piece attached to the sole and the other piece attached to the heel of said shoe, the inner edges of said pieces being substantially longitudinally aligned and the bottom surfaces of said pieces being substantially aligned to form a walking surface.

8. A foot-attached antipronation exercising device comprising a rigid base portion adapted to lie generally laterally coextensive with a wearer's foot and having an upper and a lower surface;

balance bar means depending from the outer half of said lower surface in substantially parallel relation to the base portion and positioned to the outside of the centered longitudinal axis of the base portion; means for attaching the said base portion to a wearer's foot;

said balance bar means that depends from said lower surface comprising a member having a lateral width commencing essentially from approximately the centered longitudinal axis of the base portion to the outer edge of said base, and a length generally coextensive with the length of said base.

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Appendix 11:
U.S. Pat. No. 5,087,589 by Chapman



US005087589A

United States Patent [19]

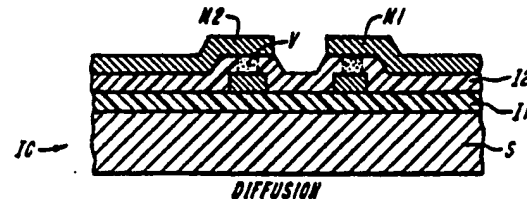
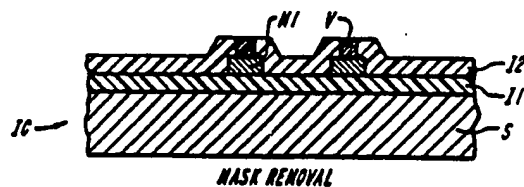
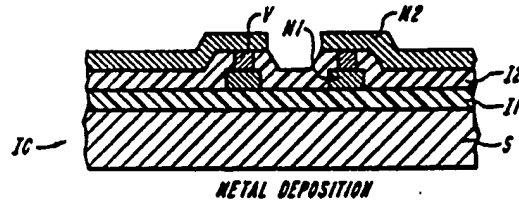
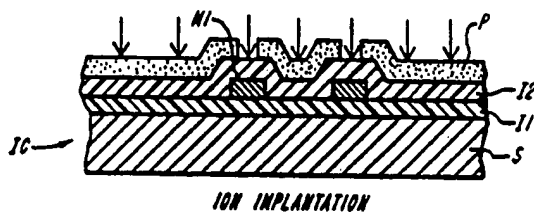
Chapman et al.

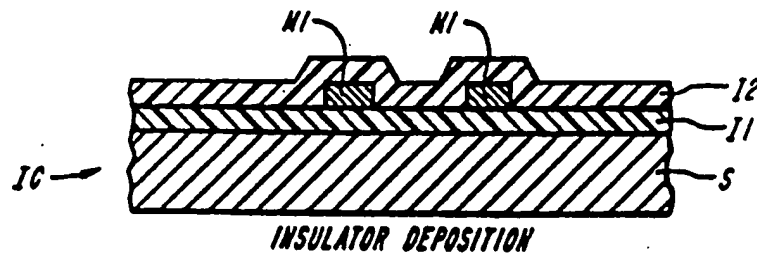
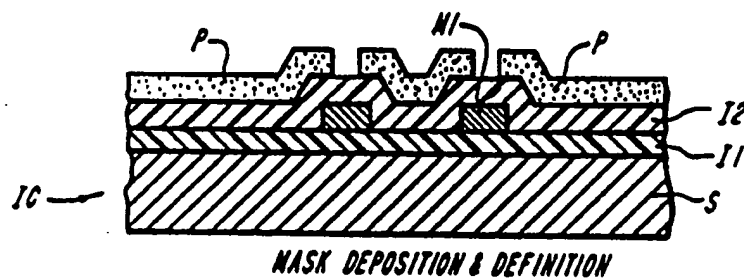
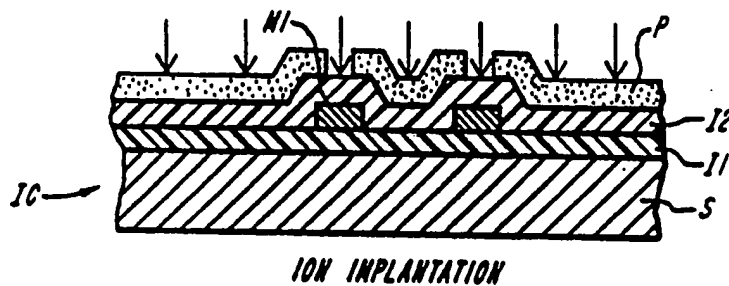
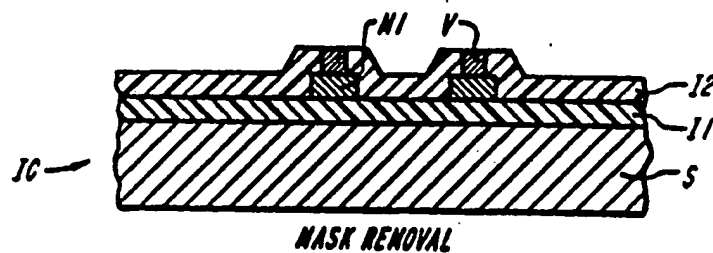
[11] Patent Number: **5,087,589**[45] Date of Patent: * **Feb. 11, 1992****[54] SELECTIVELY PROGRAMMABLE
INTERCONNECTIONS IN MULTILAYER
INTEGRATED CIRCUITS****[75] Inventors:** Glenn H. Chapman, Bedford; Terry
O. Herndon, Carlisle, both of Mass.**[73] Assignee:** Massachusetts Institute of
Technology, Cambridge, Mass.**[*] Notice:** The portion of the term of this patent
subsequent to Jun. 27, 2006 has been
disclaimed.**[21] Appl. No.:** 371,587**[22] Filed:** Jun. 26, 1989**Related U.S. Application Data****[63]** Continuation-in-part of Ser. No. 194,720, May 23,
1988, Pat. No. 4,843,034, which is a continuation-in-
part of Ser. No. 61,885, Jun. 12, 1987, abandoned.**[51] Int. Cl.³** H01L 21/44**[52] U.S. Cl.** 437/195; 437/189
437/199; 437/196; 437/24; 437/173**[58] Field of Search** 437/189, 199, 24, 173,
437/195, 196**[56] References Cited****U.S. PATENT DOCUMENTS**

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4,810,663	3/1989	Raffel et al.	437/46
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4,843,034	6/1989	Herndon et al.	437/189
4,907,066	3/1990	Thomas et al.	357/54

Primary Examiner—Brian E. Hearn*Assistant Examiner*—Trung Dang*Attorney, Agent, or Firm*—Thomas J. Engellenner**[57]****ABSTRACT**

A method of fabricating programmable interlayer conductive links in a multilayer integrated circuit structure, comprising the steps of forming elements of either a conductive or semiconductive material as a lower layer, depositing an insulative layer on top of the lower layer elements, implanting ions into one or more link regions of the insulative layer, forming at least one upper conductor over the implanted regions and selectively applying sufficient energy to at least one of the implanted regions of the integrated circuit structure to render the selected link region conductive. The invention also embraces customized integrated circuit structures with interlayer conductive paths made in accordance with this method.

25 Claims, 5 Drawing Sheets

**FIG. 1A****FIG. 1B****FIG. 1C****FIG. 1D**

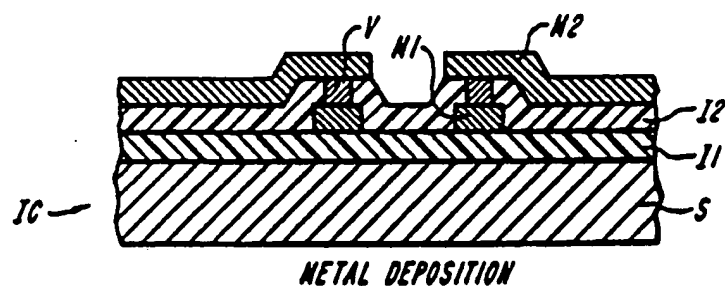


FIG. 1E

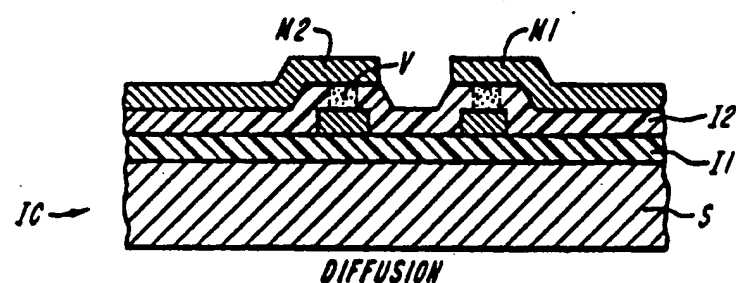


FIG. 1F

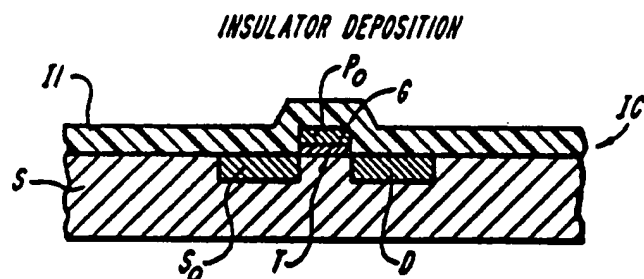


FIG. 2A

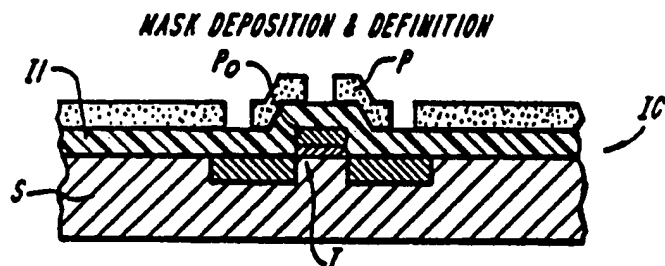
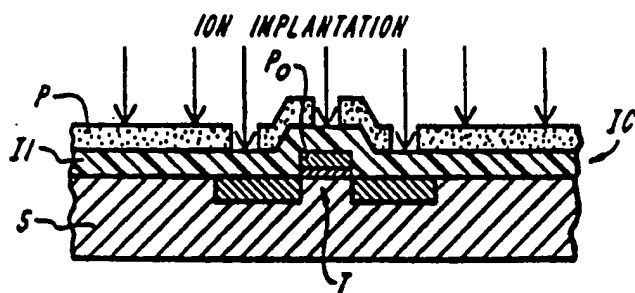
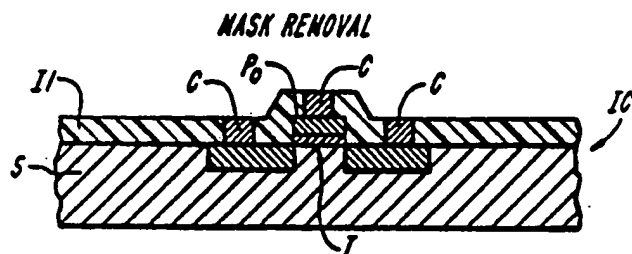
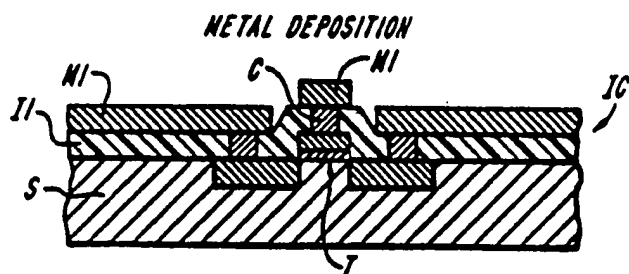
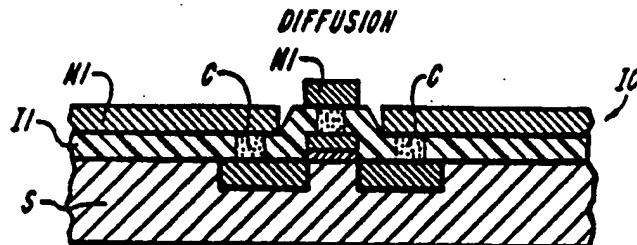


FIG. 2B

**FIG. 2C****FIG. 2D****FIG. 2E****FIG. 2F**

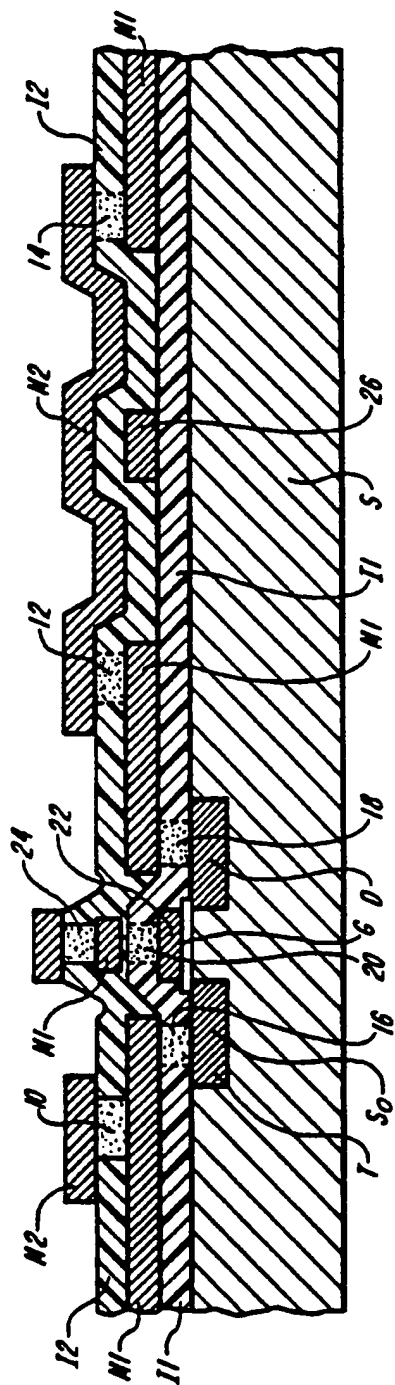
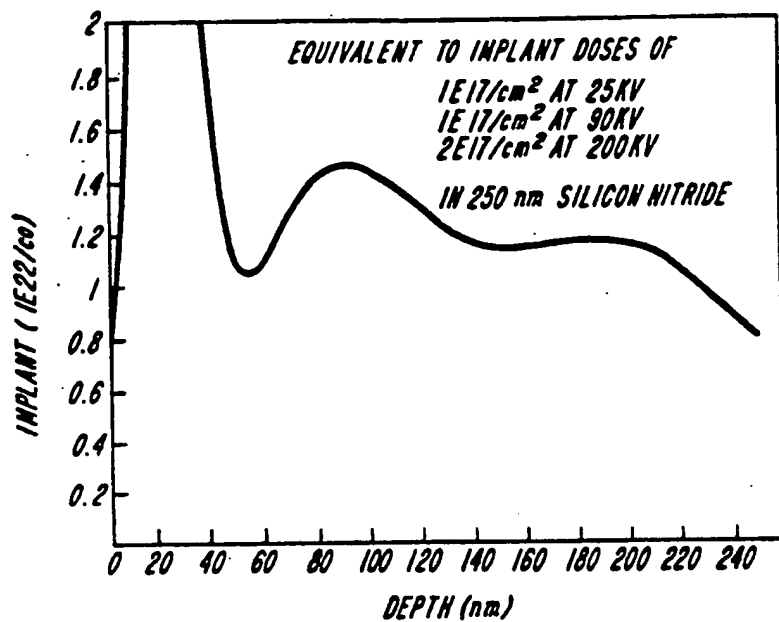
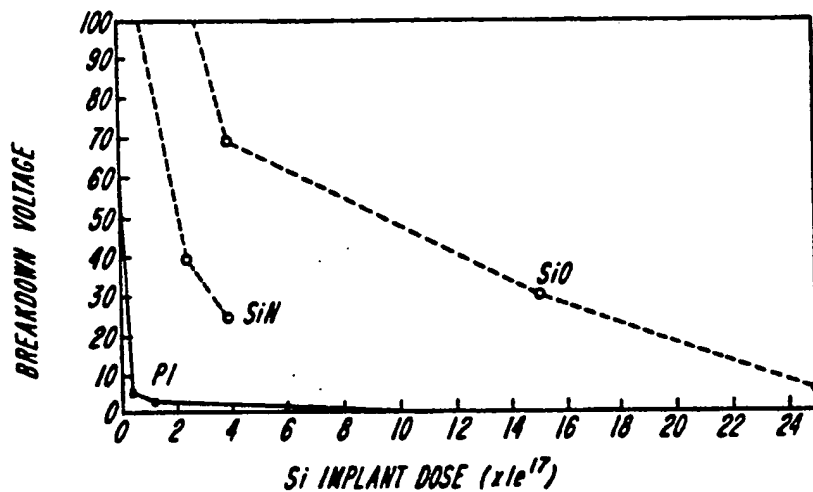


FIG. 3

**FIG. 4****FIG. 5**

SELECTIVELY PROGRAMMABLE INTERCONNECTIONS IN MULTILAYER INTEGRATED CIRCUITS

The United States Government has rights in this invention pursuant to Contract No. F19628-85-C-0002 awarded by the Department of the Air Force.

REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 194,720 filed May 23, 1988, now U.S. Pat. No. 4,843,034, which is a continuation-in-part of U.S. patent application Ser. No. 061,885 filed Jun. 12, 1987 (now abandoned).

BACKGROUND OF THE INVENTION

The technical field of this invention is solid state integrated circuit fabrication and, more particularly, methods and systems for fabricating programmable interlayer conductive paths in integrated circuits.

The rapid development of large scale integrated circuitry during the past two decades has been the result of advances in both circuit design and fabrication technology, which have allowed more circuits to be implemented on a chip. A single chip can now contain hundreds of thousands of transistors, a considerable increase over the few thousand on a chip as recently as the early 1970's.

Solid state integrated circuits are typically formed from wafers, which include a plurality of layers of conductors, active electronic devices, and passive insulators on, or within, a single semiconductor crystal. After the wafer is fabricated, it can be sliced into individual chips capable of performing discrete electronic tasks.

In this technology, an interlayer conductive path through intervening insulation between conductors in the integrated circuit is called a "via". A similar path through such insulation between an overlying conductor and a semiconductor region is called a "contact cut" (or, more descriptively, a "contact connection"). Typical wafers can have millions of such conductive paths and even moderate scale chips, containing, for example, 4,000 transistors, can have as many as 1,000 vias and over 8,000 contact connections.

Design limitations imposed by these interlayer electrical connections play an important role in present and future semiconductor circuit packing density. Very large scale integrated circuits ("VLSI") will require improved multi-level interconnects to attain performance and density goals. In theory, a three-level-metal integrated circuit permits approximately a doubling of the packing density over a two-level-metal device of similar materials and size. Device packing density, however, does not rise linearly with the increase in number of interconnected layers, but is limited by topographical area of a wafer which must be devoted to providing vias and contact cuts.

A conventional approach to constructing vias is evaporative or sputter deposition of metal into vertical directed holes. A hole is etched in an insulative layer deposited on a lower conductor, both of which overlay a substrate. A metal (which will form the overlying upper conductor) is then deposited to cover the inside and bottom of the hole and thereby establishing a conductive via through the insulative layer between the lower and upper conductors. A contact connection is fabricated in a similar way by etching a hole in which

metal is deposited to provide electrical connection between an upper conductor and an underlying semiconductor region. (In practice, after the holes are etched, metal is deposited over the entire surface of the wafer and then masked and etched away selectively to leave conductive metal lines which pass over the metal-filled vias and contact cuts).

Difficulties are often encountered in preparing a clean hole and in depositing the metal for the interlayer conductive path. For example, when the metal is deposited into a hole, the metal tends to build up and form a marginal step at the top rim of the hole, before sufficient metal is deposited to reach the bottom of the hole.

Additionally, at the center of the via, a crater is formed as the metal initially conforms to the sidewalls and bottom of the hole. The result is a very irregular top surface of the via. This condition can lead to thinning of the upper conductor, as well as non-planar deposition of subsequent layers, in the region immediately above the via.

Moreover, the planar irregularities can cause distortions in photo-resists and subsequent layers of integrated circuitry deposited above the via. When a photo-resist is deposited above a via (or an intermediate non-planar surface such as a metal conductor), the exposing light during development can be reflected by the underlying contour and lead to the narrowing or notching of the photoresist or subsequent deposits, thereby imposing limits on the resolution of device and conductor structures in these layers.

The problems associated with step coverage over vias has led to VLSI design rules which prohibit the deposition of other metal conductors directly above any via. The process of forming vias by etching holes also requires a widening of the interconnected conductors at least in the area of each via to ensure that each hole is surrounded by sufficient metal to provide tolerance in the vertical registration of conductors.

For example, a two micron wide conductor is required for a one micron wide via, and, similarly, a one micron wide conductor is needed for a $\frac{1}{2}$ micron wide via to assure sufficient overlap.

At very small dimensions, it becomes increasingly difficult to ensure continuity and integrity of vias and contact cuts. One reason for this is the difficulty at such dimensions to clean out the bottom of the hole of all insulating material prior to metal deposition. Another is the difficulty of depositing metal into such small holes.

The problem of getting metal down into the via or contact cut can be reduced by forming the hole with sloping sides. However, a vertical conductive path with sloping sides obviously takes up more space on the wafer and, as the need for smaller and smaller device structures continues, the less attractive this solution becomes. It has been estimated that with conventional via design, it will be difficult to reduce the area occupied by the via below 2×2 microns. Furthermore, steep sloping sides can make it difficult to deposit a sufficiently thick uniform conductive film on the sides of the holes.

An alternative process for filling vias is to fill the holes by chemical vapor deposition ("CVD") rather than by the evaporative or sputter deposition of metal over the entire surface of the wafer. In CVD processes it is possible to selectively grow metal layers over only those regions of the wafer where metal is already exposed. In this manner a via can be filled up from the bottom by selective deposition of a metal such as tung-

sten. However, even the most promising of the CVD processes are difficult to control, particularly when filling contact cuts, and, in any event, a hole still must be cut and then fully cleaned out before the metal can be deposited.

Another approach involves the use of lasers to convert an insulator into a conductor and thereby forming the interlayer path. Commonly owned U.S. Pat. Nos. 4,585,490 and 4,810,663 disclose a technique in which a "link insulator" is deposited where vias are desired. When a metal layer deposited above the link insulator is exposed to a high power laser having a pulse on the order of about 1 millisecond, a conductive path can be formed by melting the top metal layer and alloying at least a portion of it with the link insulator material. However, the deposition of link insulators involves materials such as amorphous silicon and silicon-rich silicon nitride which are not extensively used in the semiconductor industry.

The requirements associated with the formation of interlayer conductive paths by conventional techniques place limitations on the circuitry and affect circuit density. Consequently, it is an object of the invention to provide methods and systems for fabrication of integrated circuits with simpler design requirements, higher packing densities and more planar surfaces than those resulting from conventional interlayer connection technology.

In the above-referenced, commonly-owned patent applications, U.S. Ser. Nos. 194,720 and 061,885, methods and systems are disclosed for fabricating interlayer conductive paths by implanting ions into selected regions of normally insulative layers to change the composition and/or structure of the insulation in the selected regions. An upper conductive layer can then be deposited over such implantation regions and the entire structure sintered at a temperature between approximately 330° C. and 500° C. As a result of the low temperature sintering, atoms from the upper conductive layer or, where two conductive layers are being interconnected, from the upper and lower conductive layers, are diffused or alloyed into the implant region to form a low resistance, conductive path between the upper conductor and the underlying element, the path having a bulk resistivity of about 10^{-4} ohm-cm, or less.

The approach of U.S. Ser. Nos. 194,720 and 061,885 takes advantage of sintering steps which are already employed in semiconductor device fabrication for other purposes. Wafers are typically sintered to reduce the adverse effects of the various other processing steps during their fabrication and to improve electrical connections between conductors and the electronic devices throughout the wafer.

However, the sintering process is by its nature non-specific and ill-suited to the fabrication of variable or programmable circuits. The ability to selectively alter circuit paths in previously fabricated devices is very important for the production of user-customizable integrated circuits. The use of programmable vias, called links, enables the creation of such unique circuits.

There exists a need for better fabrication techniques for interlayer conductive paths, particularly paths which can be selectively activated or programmed to form customized gate arrays and other programmed devices.

SUMMARY OF THE INVENTION

Techniques for programming links in multilayered integrated circuits to customize gate arrays and other programmable devices are disclosed. Local application of energy, such as radiant (e.g., laser) energy or electrical stimulation, can be used to promote diffusion and thereby selectively create conductive paths in regions of an insulative material which has been previously subjected to ion implantation to form diffusion pathways. The selective radiation or electrical stimulation induces localized diffusion to create vertical conductive paths. The term "diffusion" is used herein to embrace the migration of atoms and the alloying of materials, generally.

In accordance with the invention, customized interlayer conductive paths can be produced by first depositing an insulator, either by chemical vapor deposition with or without plasma enhancement, or spin-on coating over continuous areas of the wafer on top of an already formed lower conductive layer which is to be connected to an upper conductive layer. After the insulative layer has been applied, those regions in the insulative layer through which conductive paths are desired are subjected to ion implantation. This implant step has the effect of changing the composition and/or structure of the insulation in the selected regions. The upper conductive layer is then deposited, patterned and etched into discrete conductor pathways.

In one embodiment, the application of a voltage between the upper and lower conductive layers lying opposite each other on either side of ion-implanted insulator region produces a low resistance, conductive path or an antifuse between the upper and lower conductors discretely at the point of the implanted region. The voltage required to effect this programmable link is inversely proportional to the amount of implanted ions and can be varied from a low value (3 volts) to the voltage that would normally be required to breakdown the unimplanted insulative layer (150 volts or more).

The amount of silicon implantation needed for voltage programmable links is less than the implant needed for the 425° C. sinter-activated planar vias. Thus, it is possible to employ two levels of silicon implantation which will permit planar vias and voltage programmable links to be made together on the same I.C. wafer. For example, implantation through one mask with a high silicon dose would produce the sinterable via sites with no implant being done at the voltage programmable link sites. Then, the via mask would be replaced with a voltage programmable link mask, and a lighter silicon implant would be carried out with no implant being done at the via sites. Alternatively, implantation can be done through one mask at a moderation implantation dose at both the via and programmable link sites. Then this mask can be replaced by a "via only" mask and an additional implant would significantly raise the ion dose at the via sites. In either event, the two masking-implantation sequences can be carried out using standard lithographic, etching and implantation techniques. This would achieve high-density interconnects through use of planar vias and also make possible high-density, low impedance interconnection of logic and memory circuits by voltage programming links.

In a second embodiment, the application of directed electromagnetic radiation, such as by a laser beam or the like can effect a resistive connection between the upper and lower conductors through the implanted

region of the insulator. When an argon laser beam, shuttered to make 20 μ s to 50 ms wide pulses and focused to a spot size between 1.3 and 4.2 μ m, is applied to the metal/implanted, insulator/metal structure, ohmic connections are made at power levels greater than 1.5 watts. Less than 20 ohms resistance was observed in silicon oxide implanted with silicon in excess of $1.0 \times 10^{17}/\text{cm}^2$ implant doses.

Again, the laser activated diffusion sites can also be controlled independently of sinter-activated vias. The laser activated connections in silicon oxide occur with silicon implants as low as $4.0 \times 10^{17}/\text{cm}^2$, while the 425° C. sintered planar via connections require implants in excess of $1.0 \times 10^{18}/\text{cm}^2$. Thus, although similar in behavior, implanted laser links can also be activated under conditions distinct and separate from planar vias. This means that in a circuit containing both amounts of implanted silicon, normal vertical connections can be made with planar vias by sintering, with circuit programming or structuring being done by laser activation of discrete interconnect crossings. Thus, the implantation technique can produce planar vias, as well as laser programmable interconnection links, all with the same equipment on the same I.C. wafer with one additional masking step. The planar via permits high-density multilevel interconnects, and the laser-formed additive interconnection permits discrete programming of high-density, low impedance logic and memory device interconnects.

A wide range of insulative materials can be rendered selectively conductive in this manner, including organic insulators, such as polyimides ("PI"), and inorganic insulators, such as metal oxides or semiconductor oxides, nitrides or carbides. One preferred insulator which can be processed according to the present invention to yield high resolution interlayer conductive paths is silicon dioxide, a material which is already used extensively in the industry. Other insulators include silicon nitride, and other inorganic glassy insulators generally, such as silicon carbide, aluminum oxides, diamond-structure carbon and the like.

Silicon dioxide is particularly preferred because it is already in widespread use in integrated circuit fabrication as an insulator. It is generally accepted as a choice insulator because of its low dielectric constant and because it can be epitaxially grown directly from a silicon substrate source. In addition to epitaxial growth (e.g., by exposing a silicon wafer to moisture or an oxygen-containing ambient at about 1000° C. to about 1200° C.), silicon dioxide can be deposited by sputter deposition, spin-on glass deposition, plasma deposition, CVD processes, etc., in order to obtain an insulative layer useful in constructing interlayer conductive paths according to the present invention.

Alternatively, other inorganic insulative glasses, such as silicon nitride, can be employed. When silicon nitride is used as the insulator through which interlayer conductive paths are to be formed according to the present invention, it is preferably deposited as a silicon-rich composition containing up to twice as much silicon as the normal (Si_3N_4) stoichiometric formula. Thus, preferred silicon nitride compositions can be expressed as Si_xN_y , where the ratio of x to y falls within the range of approximately 0.75 to 1.7, and is more preferably approximately 1.6. The silicon-rich Si_xN_y can be deposited, for example, by a plasma-enhanced chemical vapor deposition ("PECVD") technique or related methods. In such deposition processes, the silicon content of the

Si_xN_y can be measured by changes in the its index of refraction. For further information concerning the deposition of silicon nitride, see "Low Resistance Programmable Connections Through Plasma Deposited Silicon Nitride", by J. A. Burns, G. H. Chapman, B. L. Emerson; *Electrochemical Society Extended Abstracts*. Vol. 86-2, pg. 481 (1986) herein incorporated by reference.

A wide variety of implanted ions can be employed in the present invention to prepare the interlayer conductive paths. When silicon-based insulators are used, such as silicon dioxide or silicon nitride, it is typically preferable to use silicon ions in the implantation step as well. More generally, however, the implant ions can include ions of silicon, germanium, carbon, boron, arsenic, beryllium, phosphorus, titanium, molybdenum, aluminum and gold, depending on the particular application and materials.

The preferred implantation energy and fluence of such ions will be dependent on a number of factors, including the size of the path, the type and thickness of the insulator, and the underlying structures or substrate. Typically, the implantation energy will vary from about 10 to about 500 KeV. For some applications, such as when forming conductive paths through thick films, even higher implantation energies can be employed. Typically the implantation step can be carried out at doses ranging from about $1.0 \times 10^{16}/\text{cm}^2$ to about $1.0 \times 10^{19}/\text{cm}^2$.

Various conductor materials can be employed to provide the (upper and/or lower) conductive lines which are joined according to the present invention. Such conductor materials, including aluminum and aluminum alloys, such as Al-Si. Aluminum-based conductors are typically preferred, at least when the insulator layer is a silicon-based insulator (e.g., SiO_2 or SiN), because of the special affinity of aluminum for silicon and its ability to readily diffuse into the implant regions during sintering. Other conductor materials useful in the practice of the present invention include copper alloys, aluminum-titanium alloys, aluminum-copper-chromium alloys (or sandwiches) and the like. More generally, the conductive materials can include materials doped to conductive state, as well as naturally conductive materials, so long as the materials exhibit a suitably low initial resistivity (i.e., about 10^{-3} ohm-cm or less) and are capable of selective migration/diffusion into the implant region during activation.

Thus, present invention offers alternative techniques for fabricating interlayer conductive paths by converting an insulator to a conductor at selected sites, thereby forming an integral conductive path, in contrast to the conventional technique of removing the insulator followed by deposition of a conductor. This novel technique results in a substantially planar surface above the interlayer conductive path, and a path geometry with substantially vertical sides which can be created with high resolution.

The invention will be described below in connection with certain illustrated embodiments; however, it should be clear that various additions, subtractions and modifications can be made by those skilled in the art without departing from the spirit or scope of the claims. For example, although the invention is exemplified by vertical interlayer conductive paths, it should be clear that the techniques disclosed herein can also be used to form horizontal conductive bridges across and/or through otherwise insulative materials, as part of an

overall mass fabrication process or in order to repair or customize individual integrated circuits.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects of this invention, the various aspects and features thereof, as well as the invention itself, may be more fully understood from the following description, when read together with the accompanying drawings, in which:

FIGS. 1A-1F are sectional views of an integrated circuit structure showing vias at various stages of fabrication in accordance with the invention;

FIGS. 2A-2F are sectional views of an integrated circuit structure showing contact connections between a conductor and a semiconductor region in accordance with the invention; and

FIG. 3 is a sectional view of an integrated circuit showing a plurality of interlayer conductive paths in accordance with the invention.

FIG. 4 is a graph illustrating an exemplary ion implantation depth profile in accordance with the invention; and

FIG. 5 is a graph illustrating the dielectric breakdown voltage versus ion implantation dose for thin layers of polyimide, silicon nitride and silicon dioxide insulators.

DETAILED DESCRIPTION

FIGS. 1A through 1F, show a representative integrated circuit structure IC at various stages of fabrication in accordance with a preferred embodiment of the invention.

Referring to FIG. 1A, after a first insulative layer I1 is deposited over a substrate S, by oxidation, sputtering, chemical vapor deposition or other process well-known to those skilled in the art, a pattern of first metal conductive paths or conductors M1 is formed extending generally horizontally. This first conductive layer can be deposited, for example, by sputtering metal to a thickness of approximately 0.5 microns to 1.0 microns on the first insulative layer and then etching a pattern of horizontal metal lines in the metal layer. A second insulative layer I2 then is deposited over the first conductors M1. The insulative layer I2 can be an organic insulator, such as a polyimide, or an inorganic insulator, such as a metallic oxide or silicon-based glass. Insulative silicon compounds, such as silicon dioxide, silicon nitride, and silicon carbide, are particularly useful. The deposition of the insulative layer I2 can be achieved by known techniques, such as plasma deposition, and can result in uniform coverage of approximately 0.2 to 1.0 microns, preferably approximately 0.5 microns in thickness over a large, continuous area of the wafer, as shown.

FIG. 1B illustrates the deposition and definition of a mask P preferably of a metallic material over the insulative layer I2. The mask can be patterned by known photolithographic techniques, such as high resolution, step-on-wafer photolithography or, alternatively, by electron beam or x-ray lithography.

After exposure and development, portions of the mask are etched away to expose the I2 layer only in the areas of the voltage/laser programmable link sites. This can be achieved, for example, through known wet chemical processes, either isotropic or anisotropic. For dense circuit packing and small device size where high-aspect-ratio etching is desirable, dry plasma etching,

reactive ion etching or ion milling typically will be preferred.

After definition of the mask P, the structure is ready for ion implantation.

FIG. 1C illustrates the ion implanting step in which the exposed surface of the mask P is subjected to ions, preferably of silicon when the insulative layer I2 is an insulative silicon compound, such as SiO₂ or SiN. This effectively changes the composition and/or structure of the insulative layer in the regions exposed by the openings in the mask.

As is well known in the art, the amount of the implant, its concentration, and its distribution profile, can be all be controlled by varying the beam current, voltage and time of exposure. The implanted atoms can be selected from the group consisting of silicon, germanium, carbon, boron, arsenic, beryllium, phosphorous, titanium, molybdenum, aluminum and gold.

To attain the desired uniform distribution profile of implanted ions within the interlayer Pathway, a plurality of different beam energies can be used. For example, several implants at varying acceleration voltages can be performed to distribute ions throughout the thickness of the implantation region in order to have a more uniform distribution. Alternatively, if only one level is used, the energy can be selected to provide a Gaussian distribution of implanted ions centered in the middle of the region.

The ion implantation step changes the composition and structure of the insulative layer, and is believed also to have the effect of displacing oxygen, nitrogen, or carbon (depending upon the composition of the insulative layer) so as to promote the migration and alloying of metal from the conductive layer(s) into the implanted region during the sintering step. The implantation also is believed to have a physical effect of disrupting the crystal lattice, which may also facilitate diffusion of the metal. It results in a composite material in the implantation region essentially consisting of the disrupted insulator and implanted ions.

As an alternative to the masking step illustrated in FIG. 1B, maskless ion implantation can be utilized with certain ion sources. For example, silicon or beryllium ions can be implanted into 0.2 to 2.0 micron areas without a mask using a focussed ion beam implanter manufactured by Ion Beam Systems of Beverly, Mass.

If a mask is utilized, it typically is removed at the completion of the ion implantation step. The integrated circuit structure resulting from the implantation is shown in FIG. 1D. The implanted regions are cross-hatched and located immediately above the lower conductors M1 to be connected.

FIG. 1E illustrates the deposition of a second layer of metal conductor M2 directly on the second insulative layer I2, which proceeds in a fashion similar to that described above in connection with the first conductor layer M1. Conductor M2 is disposed directly over the implanted region which will form programmable link V.

FIG. 1F illustrates the activation of the resulting structure which results in the formation of conductive links integrally disposed within the insulative material of layer I2. The activation can be accomplished by a variety of conventional techniques. For example, selected regions of the wafer can be activated by application of an electrical voltage or laser radiation.

Thus, the effect of the selectively applied energy is to diffuse the material of conductors M1 and M2 into and

through the implant regions, thereby forming a composite conductive material. The resulting vias will have a bulk resistance on the order of about 1 ohm, well within the requirements of multi-layer integrated circuits, while the unimplanted, silicon dioxide, silicon nitride or polyimide insulative layer has a resistivity of approximately 10^{14} ohm-cm.

FIGS. 2A through 2F illustrate the fabrication steps in making contact connections C in accordance with the invention between an underlying element in the form of a semiconductor region of transistor T (having a source S_D , drain D and gate G), as well as a polysilicon layer P_0 disposed above the gate oxide. The steps are similar to those described above with reference to FIG's 1A through 1F and, therefore, require only a brief narrative. Analogous features bear the same reference letters.

In FIG. 2A, a first insulative layer I1 is deposited above the previously formed semiconductor regions formed on the substrate S, as well as above the polysilicon layer P_0 .

Subsequently, in FIG. 2B, a mask P is deposited and defined, having openings over the selected regions for the contact connections C.

In FIG. 2C, the selected regions of the integrated circuit structure are subjected to ion implantation.

Next, in FIG. 2D, the mask is removed.

In FIG. 2E, a first metal layer M1 is deposited and defined such that it is superimposed, at least in locations immediately above the implanted regions, over the underlying elements to be connected.

Finally, in FIG. 2F, the selected regions of integrated circuit structure IC are activated by selective application of energy, resulting in the formation of conductive paths through the intervening insulative layer I1, interconnecting the underlying elements with conductive layer M1. This results from the diffusion of the conductive material of the overlying first conductive layer M1 into the implanted region, forming the electrical interconnection with the underlying element.

Thus, the fabrication of contact connections according to the invention is similar to the fabrication of vias as described above.

An integrated circuit made in accordance with the invention is shown in FIG. 3. The individual horizontal conductive lines (e.g., conductor 26) of the first conductive layer M1 are insulated from the underlying substrate and active devices therein by insulative layer I1. Vertical conductive paths 10, 12, and 14 interconnect the first horizontal conductive layer M1 to a second horizontal conductive layer M2. Similarly, vertical conductive paths 16, 18 interconnect a semiconductor region of the transistor T to the first metal layer M1. Conductive path 20 interconnects a polysilicon layer 22 to the first metal layer M1. Conductive path 24 interconnects the first metal layer M1 to the second metal layer M2 and, importantly, is disposed vertically over the conductive path 20, illustrating that conductive paths in accordance with the invention can be stacked one above another.

The resulting integrated circuit has interlayer conductive paths with substantially planar top surfaces. These vertical paths can have generally cylindrical geometry or can be box-like with a square or rectangular cross-section. Two conductors in different layers can be connected, with the material of both diffusing into the implant region. Alternatively, where a semiconductor is interconnected with an overlying conductor, the material of the overlying conductor can be

diffused down into the implant region by electrical or radiant energy stimulation without affecting the underlying solid state device.

Furthermore, interlayer conductive paths made in accordance with the invention can be of equal width to that of the conductors in the link region. For example, a two micron wide conductor can be interconnected with two micron wide path, with no overlap required.

The invention is further illustrated by the following non-limiting examples.

EXAMPLE I

Electrical Programming of Ion Implanted Insulators

A pattern of metal lines was formed upon the surface of a silicon wafer by sputter deposition of a first conductive layer of Al-1%Si-2%Cu about 8000 angstroms in depth, followed by photolithographic masking and plasma etching of the unmasked regions. Insulative layers of silicon dioxide, silicon nitride and polyimide were next deposited by chemical vapor deposition or spin coating onto the surface of the wafer, covering the surface and the pattern of lower metal lines with an insulative layer of about 2500 angstroms in depth.

The insulative layers were then masked using standard photolithographic techniques so that only selected spots on the order of about 3 microns by 3 microns overlying the metal lines were exposed. Silicon ions were implanted into these regions of the SiO_2 layer using a ion implantation machine (for example, an Extorion 200-20 ion implanter manufactured by Varion, Inc. of Gloucester, Mass. or equivalent). In the region of each programmable link, an implant dose was provided at three levels: $1 \times 10^{17}/\text{cm}^2$ at 25 KeV; $1 \times 10^{18}/\text{cm}^2$ at 80 KeV; and $2 \times 10^{18}/\text{cm}^2$ at 180 KeV. FIG. 4 shows the implant profile for an SiN layer. Similar profiles were obtained for SiO and polyimide by adjusting the insulator thickness, the middle implant voltage and total implant dose.

After implantation, a second metal layer (e.g., again, an Al-Si-Cu alloy) was deposited by a plasma sputtering system (for example, a sputtering machine manufactured by CVC, Inc. of Rochester, N.Y. or equivalent) and then photolithographically patterned and etched to provide a second layer of upper conductive lines traversing the implantation regions.

Selected regions were then chosen for activation by electrical stimulation. A voltage was applied across the implantation sites. Following activation, the implantation sites were found to exhibit excellent conductivity (i.e., a low resistance on the order of 25 ohms or less) and substantially planar surfaces. The interlayer conductive paths were well bonded to the upper and lower conductive metal lines. Analysis of vertical paths and the metal lines revealed solid interdiffusion of silicon into the upper and lower conductors, as well of aluminum into the link region.

The reduction of breakdown voltage versus Si implant dosage is shown in FIG. 5 for the three insulators. The breakdown voltage of unimplanted insulation was in the range of 130-170 volts. As can be seen, the PI breakdown dropped below 10 V at implant doses in the 1.0×10^{16} to 1.0×10^{17} range. The SiN breakdown fell to 24 V at 3.0×10^{17} Si while the SiO fell to 70 V at that dose, and required 2.5×10^{18} Si to achieve breakdown below 10 V. In all cases, the voltage programmable link resistance was less than 25 ohms and in some instances less than 4 ohms (the series resistance of the probes).

Voltage programming was achieved by a current limited pulse whose voltage exceeded the conduction threshold of the implanted insulator by approximately 25%. The pulse provided sufficient Joule heating to form the connection by Al diffusion through or alloying with the insulator. Current limiting was required to prevent overheating the connection during its formation. The connection process was studied with a storage oscilloscope and the time needed to form a connection determined to be less than 2 microseconds. The need to current-limit the pulse was recognized by observing connections form and open as a result of excess heating. The voltage programming technique which appears to be preferable is to apply repeated, short pulses on the unformed link. In one illustrative embodiment, six 70 volt, current limited pulses were applied across the link. The link formed during the sixth pulse as demonstrated by the remaining pulses dropping to a low voltage across the 20 ohm resistance of the link.

EXAMPLE II

Laser Programming of Ion Implanted Insulators

A pattern of metal lines was again formed upon the surface of a silicon wafer by sputter deposition of a first conductive layer of Al-1%Si-2%Cu about 8000 angstroms in depth, followed by photolithographic masking and plasma etching of the unmasked regions. Insulative layers of silicon dioxide, silicon nitride or polyimide were again deposited by chemical vapor deposition or spin coating onto the surface of the wafer, covering the surface and the pattern of horizontal metal lines with an insulative layer of about 3000 angstroms in depth.

The insulative layers were then masked with 7000 angstrom thick AlSi and this metal mask was patterned photolithographically, plasma etched and selectively removed to expose only selected spots overlying the conductive lines. Via patterns ranging from 1-12 microns on a side were fabricated.

Silicon ions were implanted into these regions of the insulative layers again using an ion implantation machine (e.g., the Extrion 200-20 ion implanter manufactured by Varion, Inc. of Gloucester, Mass. or equivalent).

Following masking removal, an 8000 angstrom thick upper conductor of an Al-Si-Cu alloy was sputter deposited again on top, photolithographically patterned and etched to provide a second layer of upper conductive lines traversing the implantation regions.

These structures were then selectively exposed to laser radiation from an argon laser focused into a 1.3 micron diameter beam. The irradiated implantation sites again were found to exhibit excellent conductivity. In all instances the interlayer conductive paths were well bonded to the upper and lower conductive metal lines. Analysis of vertical paths and the metal lines again revealed solid interdiffusion and alloy of silicon into the upper and lower conductors as well as diffusion aluminum into the link region.

SiO₂ implanted at 8.0×10^{17} and 1.5×10^{18} was laser linked with 1 millisecond pulses at 1.5 watts to produce resistances on the order of 10 to 20 ohms. If the Si implant is reduced to 4×10^{17} , the laser power should be increased to 2.25 watts to produce equally low resistance links. Si implants below 2×10^{17} did not result in good laser links. With PI implanted at 2×10^{18} , laser links were produced at 1.4 watts, resulting in 10-20 ohm link resistance. The polyimide would not link at lower

Si implants. Silicon implanted SiN laser links were also achieved at powers ranging from about 1 to 2 watts.

In some instances, the laser activation of the programmable links is preferably carried out by a series of short pulses, for example, 60 pulses of 80 microseconds each, using an argon laser at 1.5 watts. This procedure has the advantage of reducing the laser power required to form the link and typically achieves a more uniform result.

We claim:

1. A method for selectively activating interlayer conductive paths in an integrated circuit structure, the method comprising the steps of:

- depositing an insulative layer upon a lower element of an integrated circuit structure;
- implanting ions into at least one region of the insulative layer;
- depositing an upper layer of conductive material over the implant region of the insulative layer; and
- selectively applying energy to at least one of said implant regions of said integrated circuit structure to locally diffuse material from the upper conductive layer into the selected region of the insulative layer, thereby forming a discrete conductive path in the selected region between the upper conductive layer and the lower element.

2. The method of claim 1 wherein the step of depositing an insulative layer further includes depositing a material selected from the group consisting of silicon dioxide, silicon nitride, silicon carbide, aluminum oxide, polyimide and diamond-structure carbon.

3. The method of claim 1 wherein the step of depositing an insulative layer further includes depositing a silicon dioxide layer and the step of implanting ions further includes implanting silicon ions into the selected regions of the silicon dioxide layer.

4. The method of claim 1 wherein the step of depositing an insulative layer further includes depositing a layer of silicon nitride, and the step of implanting ions further includes implanting silicon ions into the selected regions of the silicon nitride layer.

5. The method of claim 4 wherein the step of depositing an insulative layer further includes depositing a layer of polyimide and the step of implanting ions further includes implanting silicon ions into selected regions of the polyimide layer.

6. The method of claim 1 wherein the step of depositing an insulative layer further includes plasma enhanced chemical vapor deposition of the insulative layer.

7. The method of claim 1 wherein the step of implanting ions into the selected region of the insulated layer further includes masking the insulative layer so as to expose only the selected region.

8. The method of claim 1 wherein the implanting step comprises photo-lithographically patterning a resist on said insulative layer, etching the resist to create the selected exposed regions, and removing the resist after implanting said ions into the selected region.

9. The method of claim 1 wherein the step of implanting ions further includes controlling a narrow beam of ions to provide direct maskless ion implantation into the selected region.

10. The method of claim 1 wherein the step of implanting ions further includes implanting ions selected from the group consisting of silicon, germanium, carbon, boron, arsenic, phosphorous, titanium, molybdenum, aluminum, beryllium and gold.

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11. The method of claim 1 wherein the step of implanting ions further includes implanting ions at a dose ranging from about $1.0 \times 10^{16}/\text{cm}^2$ to about $1.0 \times 10^{19}/\text{cm}^2$.

12. The method of claim 1 wherein the step of depositing an upper conductive layer further includes depositing a material selected from a group consisting of alloys of aluminum, gold and platinum.

13. The method of claim 1 wherein the step of depositing the upper conductive layer further includes sputtering a conductive metal alloy onto the insulative layer and patterning said upper conductive layer to form at least one conductive metal line as the upper layer.

14. The method of claim 1 wherein the diffusion step is performed by selective application of electrical energy.

15. The method of claim 1 wherein the diffusion step is performed by selective exposure to directed electromagnetic radiation.

16. The method of claim 1 wherein the resulting interlayer conductive path in the selected region is characterized by a resistivity of less than about 10^{-3} ohm-cm.

17. The method of claim 1 wherein the lower element is a lower conductive layer.

18. The method of claim 1 wherein the lower element is a semiconductive element.

19. The method of claim 1 wherein the method further includes the steps of substantially evacuating a chamber and performing the implantation step in the substantially evacuated chamber.

20. A method of selectively activating an interlayer conductive path in a multilayer integrated circuit comprising the steps of forming a first layer and a second, generally insulative, layer thereon; implanting silicon atoms into at least one region of the insulative layer; forming a third layer on at least a portion of the insulative layer overlying the implant region, wherein one of said first or third layers is made of a conductive mate-

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rial, selectively applying sufficient energy to the selected implant region to convert the selected implant region into a generally conductive composite material and thereby locally forming a discrete conductive path through the second layer, said path vertically interconnecting the first and third layers.

21. A method of selectively activating a link for interconnecting multi-level integrated circuit conductors, including the steps of:

plasma depositing an interlayer material essentially consisting of a generally insulative silicon compound directly on a lower layer essentially of a generally conductive aluminum alloy;

implanting silicon atoms into the interlayer material through a mask having at least one opening at a selected via site;

depositing an upper layer essentially consisting of aluminum alloy directly over said implanted via sites; and

locally diffusing aluminum from said upper and lower layers into the implanted via site of the interlayer material, and thereby producing a discrete low resistance interconnection between the upper and lower layers.

22. The method of claim 21 wherein the step of implanting ions further includes implanting ions at a dose ranging from about $1.0 \times 10^{16}/\text{cm}^2$ to about $1.0 \times 10^{19}/\text{cm}^2$.

23. The method of claim 21 wherein the diffusion step further includes selective application of electrical energy.

24. The method of claim 20 wherein the diffusion step further includes selective application of directed electromagnetic radiation.

25. The method of claim 21 wherein the step of implanting ions further includes implanting ions at multiple implantation energies.

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Appendix 12:
U.S. Pat. No. 4,843,034 by Herndon

[19]

[45] **Date of Patent:** Jun. 27, 1989

- [22] Filed: May 23, 1988

[58] Field of Search 437/189, 199, 194, 195,
437/196

3,806,361	4/1974	Lehner	117/212
4,222,165	9/1980	Hartman et al.	29/571
4,425,700	1/1984	Sasaki et al.	29/571
4,585,490	4/1986	Raffel et al.	148/1.5
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4,722,913	12/1988	Miller	437/196

A method of producing interlayer conductive paths having substantially planar top surfaces in a multilayer integrated circuit structure, comprising the steps of forming elements of either a conductive or semiconductive material as a lower layer, depositing an insulative layer on top of the lower layer elements, implanting ions into one or more selected regions of the insulative layer, forming at least one upper conductor over the selected regions and sintering the integrated circuit structure sufficient to render the selected regions conductive. The invention also embraces an integrated circuit structures with interlayer conductive paths made in accordance with this method.

23 Claims, 3 Drawing Sheets

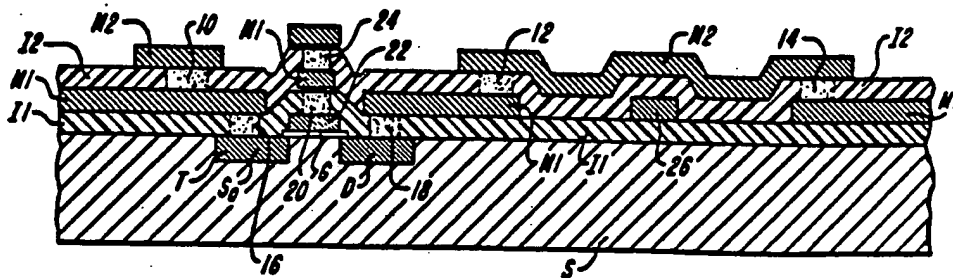


FIG. 1A
(PRIOR ART)

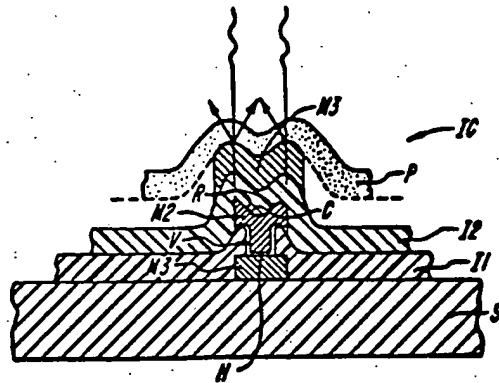
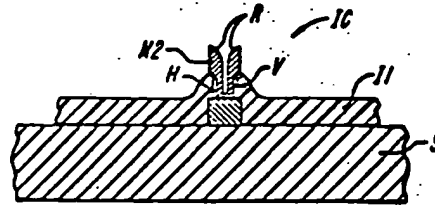
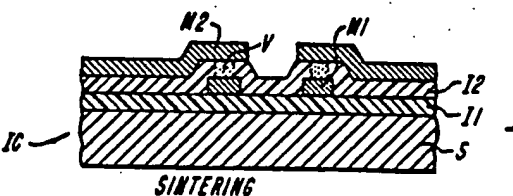
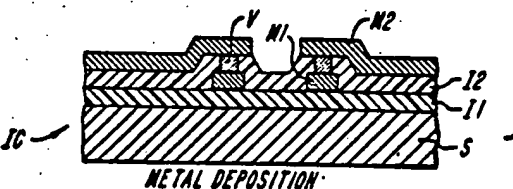
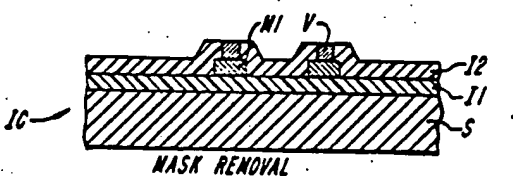
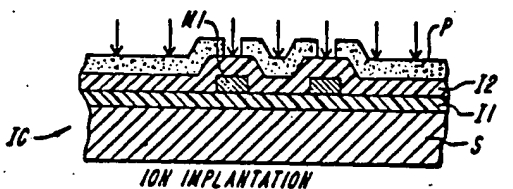
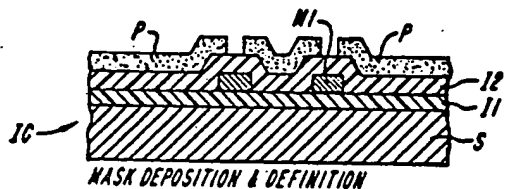
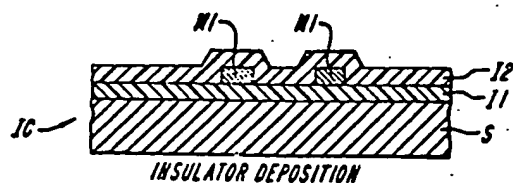


FIG. 1B
(PRIOR ART)



FABRICATION OF INTERLAYER CONDUCTIVE PATHS IN INTEGRATED CIRCUITS

The United States Government has rights in this invention pursuant to Contract No. F19628-85-C-0002 awarded by the Department of the Air Force.

REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 061,885 filed June 12, 1987, now abandoned.

BACKGROUND OF THE INVENTION

The technical field of this invention is solid state integrated circuit fabrication and, more particularly, methods and systems for fabricating interlayer conductive paths in integrated circuits.

The rapid development of large scale integrated circuitry during the past two decades has been the result of advances in both circuit design and fabrication technology, which have allowed more circuits to be implemented on a chip. A single chip can now contain hundreds of thousands of transistors, a considerable increase over the few thousand on a chip as recently as the early 1970's.

Solid state integrated circuits are typically formed from wafers, which include a plurality of layers of conductors, active electronic devices, and passive insulators on, or within, a single semiconductor crystal. After the wafer is fabricated, it can be sliced into individual chips capable of performing discrete electronic tasks.

In this technology, an interlayer conductive path through intervening insulation between conductors in the integrated circuit is called a 'via'. A similar path through such insulation between an overlying conductor and a semiconductor region is called a 'contact cut' (or, more descriptively, a 'contact connection'). Typical wafers can have millions of such conductive paths and even moderate scale chips, containing, for example, 4,000 transistors, can have as many as 1,000 vias and over 8,000 contact connections.

Design limitations imposed by these interlayer electrical connections play an important role in present and future semiconductor circuit packing density. Very large scale integrated circuits ("VLSI") will require improved multi-level interconnects to attain performance and density goals. In theory, a three-level-metal integrated circuit permits approximately a doubling of the packing density over a two-level-metal device of similar materials and size. Device packing density, however, does not rise linearly with the increase in number of interconnected layers, but is limited by topographical area of a wafer which must be devoted to providing vias and contact cuts.

A conventional approach to constructing vias is evaporative or sputter deposition of metal into vertical directed holes, as illustrated in FIGS. 1A and 1B. A hole H is etched in an insulative layer I1 deposited on a lower conductor M1, both of which overlay substrate S. A metal M2 (which will form the overlying upper conductor) is then deposited to cover the inside and bottom of the hole H, and thereby establishing a conductive via V through the insulative layer I1 between the lower and upper conductors M1, and M2. A contact connection is fabricated in a similar way by etching a hole in which metal is deposited to provide electrical connection between an upper conductor and an under-

lying semiconductor region. (In practice, after the holes are etched, metal is deposited over the entire surface of the wafer and then masked and etched away selectively to leave conductive metal lines which pass over the metal-filled vias and contact cuts).

Difficulties are often encountered in preparing a clean hole and in depositing the metal for the interlayer conductive path. For example, with reference to the illustrations of FIGS. 1A and 1B, when the metal is deposited into the hole H, the metal tends to build up and form a marginal step at the top rim of the hole, designated R in these figures, before sufficient metal is deposited to reach the bottom of the hole H.

Additionally, at the center of the via V, a crater C is formed as the metal initially conforms to the sidewalls and bottom of the hole. The result is a very irregular top surface of the via V. The non-planar topography can be appreciated from FIGS. 1A and 1B which clearly show this 'crater rim' phenomenon. This condition can lead to thinning of the upper conductor M2, as well as non-planar deposition of subsequent layers such as insulating layer I2 and metal layer M3, as shown in FIG. 1B, in the region immediately above the via V.

Moreover, the planar irregularities can cause distortions in photo-resists and subsequent layers of integrated circuitry deposited above the via. Again, as shown in FIG. 1B, when a photoresist P is deposited above a via (or an intermediate non-planar surface such as metal conductor M3), the exposing light during development can be reflected by the underlying contour and lead to the narrowing or notching of the photoresist or subsequent deposits, thereby imposing limits on the resolution of device and conductor structures in these layers.

The problems associated with step coverage over vias has led to VLSI design rules which prohibit the deposition of other metal conductors directly above any via. The process of forming vias by etching holes also requires a widening of the interconnected conductors at least in the area of each via to ensure that each hole is surrounded by sufficient metal to provide tolerance in the vertical registration of conductors.

For example, a two micron wide conductor is required for a one micron wide via as shown in FIG. 1B, and similarly a one micron wide conductor is needed for a $\frac{1}{2}$ micron wide via as shown in FIG. 1A, to assure sufficient overlap.

At very small dimensions, it becomes increasingly difficult to ensure continuity and integrity of vias and contact cuts. One reason for this is the difficulty at such dimensions to clean out the bottom of the hole H of all insulating material prior to metal deposition. Another is the difficulty of depositing metal into such small holes.

The problem of getting metal down into the via or contact cut can be reduced by forming the hole with sloping sides. However, a vertical conductive path with sloping sides obviously takes up more space on the wafer and, as the need for smaller and smaller device structures continues, the less attractive this solution becomes. It has been estimated that with conventional via design, it will be difficult to reduce the area occupied by the via below 2×2 microns. Furthermore, steep sloping sides can make it difficult to deposit a sufficiently thick uniform conductive film on the sides of the holes.

An alternative process for filling vias is to fill the holes by chemical vapor deposition ("CVD") rather than by the evaporative or sputter deposition of metal

over the entire surface of the wafer. In CVD processes it is possible to selectively grow metal layers over only those regions of the wafer where metal is already exposed. In this manner a via can be filled up from the bottom by selective deposition of a metal such as tungsten. However, even the most promising of the CVD processes are difficult to control, particularly when filling contact cuts, and, in any event, a hole still must be cut and then fully cleaned out before the metal can be deposited.

Another approach involves the use of lasers to convert an insulator into a conductor and thereby forming the interlayer path. Commonly owned U.S. Pat. No. 4,485,490 discloses a technique in which a 'link insulator' is deposited where vias are desired. When a metal layer deposited above the link insulator is exposed to a high power laser having a pulse on the order of about 1 millisecond, a conductive path can be formed by melting the top metal layer and alloying at least a portion of it with the link insulator material. While this technique appears to be an efficient means for selectively making vias and contact cuts, the resulting structures typically still present non-planar surfaces and involve localized exposure to high temperatures (e.g., higher than 500° C.) generated by the laser beam, which requires careful control.

Thus, the requirements associated with the formation of interlayer conductive paths by conventional techniques place limitations on the circuitry and affect circuit density. Consequently, it is an object of the invention to provide methods and systems for fabrication of integrated circuits with simpler design requirements than those resulting from conventional interlayer connection technology.

Another object of the invention is to provide methods of fabricating interlayer conductive paths which permit higher packing densities of active electronic devices in integrated circuit chips.

It is yet another object of the invention to provide interlayer conductive paths with improved geometry, having substantially planar upper surfaces and substantially vertical sides.

SUMMARY OF THE INVENTION

Methods and systems are disclosed for fabricating interlayer conductive paths by implanting ions into selected regions of normally insulative layers to change the composition and/or structure of the insulation in the selected regions. An upper conductive layer can then be deposited over such implantation regions and the entire structure sintered at a temperature between approximately 330° C. and 500° C. As a result of the low temperature sintering, atoms from the upper conductive layer or, where two conductive layers are being interconnected, from the upper and lower conductive layers, are diffused into the implant region to form a low resistance, conductive path between the upper conductor and the underlying element, the path having a bulk resistivity of about 10^{-4} ohm-cm, or less.

This approach can take advantage of sintering steps which are already employed in semiconductor device fabrication for other purposes. Wafers are typically sintered to reduce the adverse effects of the various other processing steps during their fabrication and to improve electrical connections between conductors and the electronic devices throughout the wafer.

A wide range of insulative materials can be rendered selectively conductive in this manner, including poly-

meric insulators, such as polyimides, and inorganic insulators, such as metal or semiconductor oxides, nitrides or carbides. One preferred insulator which can be processed according to the present invention to yield high resolution interlayer conductive paths is silicon dioxide, a material which is already used extensively in the industry. Other insulators include silicon nitride, and other inorganic glassy insulators generally, such as silicon carbide, aluminum oxides, diamond-structure carbon and the like.

Silicon dioxide is particularly preferred because it is already in widespread use in integrated circuit fabrication as an insulator. It is generally accepted as a choice insulator because of its low dielectric constant and because it can be epitaxially grown from a source silicon substrate. In addition to epitaxial growth (e.g., by exposing a silicon wafer to moisture or an oxygen-containing ambient at about 1000° C. to about 1200° C.), silicon dioxide can be deposited by sputter deposition, spin-on glass deposition, plasma deposition, CVD processes, etc., in order to obtain an insulative layer useful in constructing interlayer conductive paths according to the present invention.

Alternatively, other inorganic insulative glasses, such as silicon nitride, can be employed. When silicon nitride is used as the insulator through which interlayer conductive paths are to be formed according to the present invention, it is preferably deposited as a silicon-rich composition containing up to twice as much silicon as the normal (Si_3N_4) stoichiometric formula. Thus, preferred silicon nitride compositions can be expressed as Si_xN_y , where the ratio of x to y falls within the range of approximately 0.75 to 1.7, and is more preferably approximately 1.6. The silicon-rich Si_xN_y can be deposited, for example, by a plasma-enhanced chemical vapor deposition ("PECVD") technique or related methods. In such deposition processes, the silicon content of the Si_xN_y can be measured by changes in the its index of refraction.

A wide variety of implanted ions can be employed in the present invention to prepare the interlayer conductive paths. When silicon-based insulators are used, such as silicon dioxide or silicon nitride, it is typically preferable to use silicon ions in the implantation step as well. More generally, however, the implant ions can include ions of silicon, germanium, carbon, boron, arsenic, phosphorus, titanium, molybdenum, aluminum and gold, depending on the particular application and materials. The preferred implantation energy and fluence of such ions will be dependent on a number of factors, including the size of the path, the type and thickness of the insulator, and the underlying structures or substrate. Typically, the implantation energy will vary from about 10 to about 500 KeV. For some applications, such as when forming conductive paths through thick films, even higher implantation energies can be employed.

Various conductor materials can be employed to provide the (upper and/or lower) conductive lines which are joined according to the present invention. Such conductor materials, including aluminum and aluminum alloys, such as Al-Si. Aluminum-based conductors are typically preferred, at least when the insulator layer is a silicon-based insulator (e.g., SiO_2 or SiN), because of the special affinity of aluminum for silicon and its ability to readily diffuse into the implant regions during sintering. Other conductor materials useful in the practice of the present invention include copper alloys, aluminum-titanium alloys, aluminum-copper-

chromium alloys (or sandwiches) and the like. More generally, the conductive materials can include materials doped to conductive state, as well as naturally conductive materials, so long as the materials exhibit a suitably low initial resistivity (i.e., about 10^{-3} ohm-cm or less) and are capable of selective migration/diffusion into the implant region during sintering.

Thus, present invention offers an alternative technique for fabricating interlayer conductive paths by converting an insulator to a conductor at selected sites, thereby forming an integral conductive path, in contrast to the conventional technique of removing the insulator followed by deposition of a conductor. This novel technique results in a substantially planar surface above the interlayer conductive path, and a path geometry with substantially vertical sides which can be created with high resolution.

The invention will be described below in connection with certain illustrated embodiments; however, it should be clear that various additions, subtractions and modifications can be made by those skilled in the art without departing from the spirit or scope of the claims. For example, although the invention is exemplified by vertical interlayer conductive paths, it should be clear that the techniques disclosed herein can also be used to form horizontal conductive bridges across and/or through otherwise insulative materials, as part of an overall mass fabrication process or in order to repair or customize individual integrated circuits.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects of this invention, the various aspects and features thereof, as well as the invention itself, may be more fully understood from the following description, when read together with the accompanying drawings, in which:

FIGS. 1A and 1B show sectional views of an integrated circuit with vias made in accordance with the prior art;

FIGS. 2A-2F are sectional views of an integrated circuit structure showing vias at various stages of fabrication in accordance with the invention;

FIGS. 3A-3F are sectional views of an integrated circuit structure showing contact connections between a conductor and a semiconductor region in accordance with the invention; and

FIG. 4 is a sectional view of an integrated circuit showing a plurality of interlayer conductive paths in accordance with the invention.

DETAILED DESCRIPTION

FIGS. 2A through 2F, show a representative integrated circuit structure IC at various stages of fabrication in accordance with a preferred embodiment of the invention.

Referring to FIG. 2A, after a first insulative layer I1 is deposited over a substrate S, by oxidation, sputtering, chemical vapor deposition or other process well-known to those skilled in the art, a pattern of first metal conductive paths or conductors M1 is formed extending generally horizontally. This first conductive layer can be deposited, for example, by sputtering metal to a thickness of approximately 0.5 microns to 1.0 microns on the first insulative layer and then etching a pattern of horizontal metal lines in the metal layer. A second insulative layer I2 then is deposited over the first conductors M1. The insulative layer I2 can be a polymeric insulator, such as a polyimide, or an inorganic insulator,

such as a metallic or semiconductor glass. Insulative silicon compounds, such as silicon dioxide, silicon nitride, and silicon carbide, are particularly useful. The deposition of the insulative layer I2 can be achieved by known techniques, such as plasma deposition, and can result in uniform coverage of approximately 0.2 to 1.0 microns, preferably approximately 0.5 microns in thickness over a large, continuous area of the wafer, as shown.

FIG. 2B illustrates the deposition and definition of a mask P preferably of a metallic material over the insulative layer I2. The mask can be patterned by known photolithographical techniques, such as high resolution, step-on-wafer photolithography or, alternatively, by electron beam or x-ray lithography.

After exposure and development, portions of the mask are etched away to expose the I2 layer only in the areas of the via sites. This can be achieved, for example, through known wet chemical processes, either isotropic or anisotropic. For dense circuit packing and small device size where high-aspect-ratio etching is desirable, dry plasma etching, reactive ion etching or ion milling typically will be preferred.

After definition of the mask P, the structure is ready for ion implantation.

FIG. 2C illustrates the ion implanting step in which the exposed surface of the mask P is subjected to ions, preferably of silicon when the insulative layer I2 is an insulative silicon compound, such as SiO_2 or SiN . This effectively changes the composition and/or structure of the insulative layer in the regions below the openings in the mask.

As is well known in the art, the amount of the implant, its concentration, and its distribution profile, can be all be controlled by varying the beam current, voltage and time of exposure. The implanted atoms can be selected from the group consisting of silicon, germanium, carbon, boron, arsenic, phosphorous, titanium, molybdenum, aluminum and gold.

To attain the desired uniform distribution profile of implanted ions within the interlayer pathway, a plurality of different beam energies can be used. For example, several implants at varying acceleration voltages can be performed to distribute ions throughout the thickness of the implantation region in order to have a more uniform distribution. Alternatively, if only one level is used, the energy can be selected to provide a Gaussian distribution of implanted ions centered in the middle of the region.

The ion implantation step changes the composition and structure of the insulative layer, and is believed also to have the effect of displacing oxygen, nitrogen, or carbon (depending upon the composition of the insulative layer) so as to promote the migration and alloying of metal from the conductive layer(s) into the implanted region during the sintering step. The implantation also is believed to have a physical effect of disrupting the crystal lattice, which may also facilitate diffusion of the metal. It results in a composite material in the implantation region essentially consisting of the disrupted insulator and implanted ions.

As an alternative to the masking step illustrated in FIG. 2B, maskless ion implantation can be utilized with certain ion sources. For example, silicon or gold ions can be implanted into 0.2 to 2.0 micron areas without a mask using a focussed ion beam implanter manufactured by Ion Beam Systems of Beverly, Mass.

If a mask is utilized, it typically is removed at the completion of the ion implantation step. The integrated circuit structure resulting from the implantation is shown in FIG. 2D. The implanted regions are cross-hatched and located immediately above the lower conductors M1 to be connected.

FIG. 2E illustrates the deposition of a second layer of metal conductor M2 directly on the second insulative layer I2, which proceeds in a fashion similar to that described above in connection with the first conductor layer M1. Conductor M2 is disposed directly over the implanted region which will form via V.

FIG. 2F illustrates the sintering of the resulting structure which results in the formation of conductive vias integrally disposed within the insulative material of layer I2. The sintering can be accomplished by conventional techniques. For example, the wafer can be placed in an oven in a non-reactive gas atmosphere (typically nitrogen with, on the order of approximately three percent added hydrogen to absorb oxygen) and heated.

The temperature should be elevated to between about 330° C. and 500° C. depending on sintering time, and preferably about 425° C. for one half hour. In any event, the sintering temperature should be below the melting temperature of the material of the conductors M1 and M2, which for aluminum-based conductors is about 600° C.

Thus, the effect of the sintering is to diffuse the material of conductors M1 and M2 into and through the implant regions, thereby forming a composite conductive material. The resulting vias will have a bulk resistance on the order of about 1 ohm, well within the requirements of multi-layer integrated circuits, while the unprocessed silicon nitride of the insulative layer, for example, has a resistivity of approximately 10^{14} ohm-cm.

Since a wafer is typically sintered to improve electrical interconnections and reduce the adverse effects of prior fabrication processing steps, the sintering in the formation of vias does not add a further step to the wafer fabrication process.

FIGS. 3A through 3F illustrate the fabrication steps in making contact connections C in accordance with the invention between an underlying element in the form of a semiconductor region of transistor T (having a source S_p , drain D and gate G), as well as a polysilicon layer P_p disposed above the gate oxide. The steps are similar to those described above with reference to FIG's 2A through 2F and, therefore, require only a brief narrative. Analogous features bear the same reference letters.

In FIG. 3A, a first insulative layer I1 is deposited above the previously formed semiconductor regions formed on the substrate S, as well as above the polysilicon layer P_p .

Subsequently, in FIG. 3B, a mask P is deposited and defined, having openings over the selected regions for the contact connections C.

In FIG. 3C, the selected regions of the integrated circuit structure are subjected to ion implantation.

Next, in FIG. 3D, the mask is removed.

In FIG. 3E, a first metal layer M1 is deposited and defined such that it is superimposed, at least in locations immediately above the implanted regions, over the underlying elements to be connected.

Finally, in FIG. 3F, the integrated circuit structure IC is sintered, resulting in the formation of conductive paths through the intervening insulative layer I1, interconnecting the underlying elements with conductive

layer M1. This results from the diffusion of the conductive material of the overlying first conductive layer M1 into the implanted region, forming the electrical interconnection with the underlying element.

Thus, the fabrication of contact connections according to the invention is similar to the fabrication of vias as described above.

An integrated circuit made in accordance with the invention is shown in FIG. 4. The individual horizontal conductive lines (e.g., conductor 26) of the first conductive layer M1 are insulated from the underlying substrate and active devices therein by insulative layer I1. Vertical conductive paths 10, 13, 14 interconnect the first horizontal conductive layer M1 to a second horizontal conductive layer M2. Similarly, vertical conductive paths 16, 18 interconnect a semiconductor region of the transistor T to the first metal layer M1. Conductive path 20 interconnects a polysilicon layer 22 to the first metal layer M1. Conductive path 24 interconnects the first metal layer M1 to the second metal layer M2 and, importantly, is disposed vertically over the conductive path 20, illustrating that conductive paths in accordance with the invention can be stacked one above another.

The resulting integrated circuit has interlayer conductive paths with substantially planar top surfaces. These vertical paths can have generally cylindrical geometry or can be box-like with a square or rectangular cross-section. Two conductors in different layers can be connected, with the material of both diffusing into the implant region. Alternatively, where a semiconductor is interconnected with an overlying conductor, the material of the overlying conductor can be diffused down into the implant region by sintering without affecting the underlying solid state device.

Furthermore, interlayer conductive paths made in accordance with the invention can be of equal width to that of the conductors in the link region. For example, a two micron wide conductor can be interconnected with two micron wide path, with no overlap required.

The invention is further illustrated by the following non-limiting examples.

EXAMPLE I - SILICON DIOXIDE

A pattern of metal lines was formed upon the surface of a silicon wafer by sputter deposition of a first conductive layer of Al-1%Si-2%Cu about 8000 angstroms in depth, followed by photolithographic masking and plasma etching of the unmasked regions. A silicon dioxide insulative layer was next deposited by plasma enhanced chemical vapor deposition (from silane and NO_2) onto the surface of the wafer, covering the surface and the pattern of lower metal lines with an insulative SiO_2 layer of about 2500 angstroms in depth.

The silicon dioxide layer was then masked using standard photolithographic techniques so that only selected spots on the order of about 3 microns by 3 microns overlying the metal lines were exposed. Silicon ions were implanted into these regions of the SiO_2 layer using a direct implantation machine (for example, an Extrion 200-20 ion implanter manufactured by Varion, Inc. of Gloucester, Mass. or equivalent). In the region of each via, an implant dose was provided at three levels: $5 \times 10^{17}/\text{cm}^2$ at 25 KeV; $1 \times 10^{18}/\text{cm}^2$ at 80 KeV; and $2 \times 10^{18}/\text{cm}^2$ at 180 KeV.

After implantation, a second metal layer (e.g., aluminum with 1% silicon) was deposited by a plasma sputtering system (for example, a sputtering machine manufactured by CVC, Inc. of Rochester, N.Y. or equivalent).

lent) and then photolithographically patterned and etched to provide a second layer of upper conductive lines traversing the implantation regions.

The entire structure was then sintered at 450° C. for one-half hour. Following sintering, the implantation sites were found to exhibit excellent conductivity (i.e., a low resistance on the order of 1.5 ohms) and substantially planar surfaces. The interlayer conductive paths were well bonded to the upper and lower conductive metal lines. Analysis of vertical paths and the metal lines revealed solid interdiffusion of silicon into the upper and lower conductors, as well of aluminum into the via region.

EXAMPLE 2 - SILICON NITRIDE

A pattern of metal lines was again formed upon the surface of a silicon wafer by sputter deposition of a first conductive layer of Al-1%Si-2%Cu about 8000 angstroms in depth, followed by photolithographic masking and plasma etching of the the unmasked regions. A silicon nitride insulative layer was next deposited by plasma enhanced chemical vapor deposition onto the surface of the wafer, covering the surface and the pattern of horizontal metal lines with an insulative SiO₂ layer of about 3000 angstroms in depth.

In this process, silicon nitride was formed from silane and ammonia gases and was deposited using PECVD equipment manufactured by Tegal Corporation of California. For further information concerning the deposition of silicon nitride, see "Low Resistance Programmable Connections Through Plasma Deposited Silicon Nitride", by J. A. Burns, G. H. Chapman, B. L. Emerson; *Electrochemical Society Extended Abstracts*, Vol. 86-2, pg. 481 (1986) herein incorporated by reference.

As noted above, it was found that silicon-rich SiN was preferable for ion implantation purposes. The chemistry of the deposited material was monitored by measuring its index of refraction as an indication of the silicon content. An index of refraction between about 2.2 and 2.5, as measured, for example, by ellipsometric techniques known in the art, was found to be desirable.

The silicon nitride layer was then masked with 7000 angstrom thick AlSi and this metal mask was patterned photolithographically, plasma etched and selectively removed to expose only selected spots overlying the conductive lines. Via patterns ranging from 1-12 microns on a side were fabricated.

Silicon ions were implanted into these regions of the SiN layer again using a direct implantation machine (e.g., the Extrion 200-20 ion implanter manufactured by Varion, Inc. of Gloucester, Mass. or equivalent). In the region of each via, an implant dose was provided at three levels: $1 \times 10^{17}/\text{cm}^2$ at 25 KeV, 90 KeV and 180 KeV.

Following masking removal, an 8000 angstrom thick upper conductor of Al-1%Si was sputter deposited again on top, photolithographically patterned and etched to provide a second layer of upper conductive lines traversing the implantation regions.

This SiN structure was sintered at 425° C. for one-half hour. Following sintering, the implantation sites again were found to exhibit excellent conductivity (i.e. a resistance of less than 1.0 ohm for vias on the order of one micron by one micron in cross section). Low resistance paths were also achieved with 330° C. sintering. In all instances the vias exhibited substantially planar surfaces and the interlayer conductive paths were well bonded to the upper and lower conductive metal lines.

Analysis of vertical paths and the metal lines again revealed solid interdiffusion of silicon into the the upper and lower conductors as well of aluminum into the via region.

We claim:

1. A method for producing interlayer conductive paths in an integrated circuit structure, the method comprising the steps of:

depositing an insulative layer upon a lower element of an integrated circuit structure;

implanting ions into at least one selected region of the insulative layer to form a modified region possessing a diffusion pathway for alloying with a conductive material;

depositing an upper layer of conductive material over the selected region of the insulative layer; and

sintering the deposited layers and integrated circuit structure to diffuse material from the upper conductive layer into said selected region of the insulative layer, thereby forming a conductive path in the selected region between the upper conductive layer and the lower element.

2. The method of claim 1 wherein the step of depositing an insulative layer further includes depositing a material selected from the group consisting of silicon dioxide, silicon nitride, silicon carbide, aluminum oxide, polyimide and diamond-structure carbon.

3. The method of claim 1 wherein the step of depositing an insulative layer further includes depositing ions further includes implanting silicon ions into the selected regions of the silicon dioxide layer.

4. The method of claim 1 wherein the step of depositing an insulative layer further includes depositing a layer of silicon nitride, and the step of implanting ions further includes implanting silicon ions into the selected regions of the silicon nitride layer.

5. The method of claim 4 wherein the step of depositing an insulative material further includes depositing a silicon-rich, silicon nitride layer having a ratio of silicon to nitride in the range of 0.75 to 1.7.

6. The method of claim 1 wherein the step of depositing an insulative layer further includes plasma enhanced chemical vapor deposition of the insulative layer.

7. The method of claim 1 wherein the step of implanting ions into the selected region of the insulated layer further includes masking the insulative layer so as to expose only the selected region.

8. The method of claim 1 wherein the implanting step comprises photo-lithographically patterning a resist on said insulative layer, etching the resist to create the selected exposed regions, and removing the resist after implanting said ions into the selected region.

9. The method of claim 1 wherein the step of implanting ions further includes controlling a narrow beam of ions to provide direct maskless ion implantation into the selected region.

10. The method of claim 1 wherein the step of implanting ions further includes implanting ions selected from the group consisting of silicon, germanium, carbon, boron, arsenic, phosphorous, titanium, molybdenum, aluminum and gold.

11. The method of claim 1 wherein the step of depositing an upper conductive layer further includes depositing a material selected from a group consisting of alloys of aluminum, gold and platinum.

12. The method of claim 1 wherein the step of depositing said upper conductive layer further includes depositing an aluminum alloy.

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13. The method of claim 1 wherein the step of depositing the upper conductive layer further includes sputtering a conductive metal alloy onto the insulative layer and patterning said upper conductive layer to form at least one conductive metal line as the upper layer.

14. The method of claim 1 wherein the sintering step is performed in a substantially non-reactive atmosphere.

15. The method of claim 1 wherein the sintering step includes elevating the temperature of said deposited layers and integrated circuit structure to between about 300° C. and 500° C.

16. The method of claim 1 wherein the resulting interlayer conductive path in the selected region is characterized by a resistivity of less than about 10^{-3} ohm-cm.

17. The method of claim 1 wherein the lower element is a lower conductive layer.

18. The method of claim 1 wherein the lower element is a semiconductor element.

19. The method of claim 1 wherein the method further includes the steps of substantially evacuating a chamber and performing the implantation step in the substantially evacuated chamber.

20. A method of producing an interlayer conductive path in a multilayer integrated circuit, the method comprising the steps of forming a first layer and a second, generally insulative, layer thereon; implanting silicon atoms into at least one selected region of the insulative layer to form a modified region possessing a diffusion pathway for alloying with a conductive material; forming a third layer on at least a portion of the insulative layer overlying the selected region, wherein one of said first or third layers is made of a conductive material;

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sintering the first, second and third layers at a temperature sufficient to convert the selected implanted region into a generally conductive composite material; and thereby selectively forming a generally conductive path through the second layer, said path vertically interconnecting the first and third layers.

21. A method of for producing a via for interconnecting multilevel integrated circuit conductors, the method comprising the steps of:

plasma depositing an interlayer material essentially consisting of a generally insulative, silicon compound directly on a lower layer essentially consisting of a generally conductive aluminum alloy; implanting silicon atoms into the interlayer material through a mask having at least one opening at a selected via site to form a modified region possessing a diffusion pathway for alloying with a conductive material;

depositing an upper layer essentially consisting of an aluminum alloy directly over said implanted via site; and

diffusing aluminum from said upper and lower layers into the implanted via site of the interlayer material, and thereby producing a low resistance interconnection between the upper and lower layers.

22. The method of claim 20 wherein the sintering step includes sintering the deposited layers at about the crystallization temperature of amorphous silicon.

23. The method of claim 21 wherein the step of implanting ions further includes implanting ions at multiple implantation energies.

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Appendix 13:

In re Rasmussen, 650 F.2d 1212, 211 U.S.P.Q. 323 (C.C.P.A. 1981)

In re Rasmussen

Court of Customs and Patent Appeals

No. 81-516

Decided June 4, 1981

United States Patents Quarterly Headnotes

PATENTS

[1] Amendments to patent application -- New matter (§ 13.5)

Claims -- Specification must support (§ 20.85)

35 U.S.C. 132 prohibits introduction of new matter into disclosure of application; 35 U.S.C. 112, first paragraph, requires that claim language be supported in specification.

PATENTS

[2] Amendments to patent application -- New matter (§ 13.5)

Claims -- Broad or narrow -- In general (§ 20.201)

Specification -- Claims as disclosure (§ 62.3)

Broadening claim does not add new matter to disclosure; disclosure is that which is taught, not that which is claimed; original claim is part of disclosure at time of filing; consideration of original claim as evidencing support in disclosure for later submitted claims does not warrant employment of 35 U.S.C. 132 as basis for rejection of later submitted claims on ground that latter are adding new matter to original claim portion of disclosure; to do so would render Section 132 redundant in light of Section 112, first paragraph; applicant is entitled to claims as broad as prior art and his disclosure will allow.

PATENTS

[3] Amendments to patent application -- New matter (§ 13.5)

Claims -- Specification must support (§ 20.85)

Pleading and practice in Patent Office -- Rejections (§ 54.7)

Proper basis for rejection of claim amended to recite elements thought to be without support in original disclosure is 35 U.S.C. 112, first paragraph, not Section 132; latter section prohibits addition of new matter to original disclosure; it is properly employed as basis for objection to amendments to abstract, specifications, or drawings attempting to add new disclosures to that originally presented; past opinions of Court of Customs and Patent Appeals, in cases in

which Section 132 claim rejection was reviewed on Section 112 analysis, should not in future be viewed as having approved employment of Section 132 as basis for claim rejection; amended claims involved in those cases should have been rejected under Section 112, first paragraph; claim rejections in those cases could then have been explicitly affirmed or reversed on direct applications of Section 112, rather than on Section 112 analyses applied to Section 132 rejections; similarly, rejections of claims for lack of support when required in reissue applications should be made under Section 112, first paragraph, rather than under new matter prohibition of 35 U.S.C. 251; accordingly, such cases are overruled insofar as they approved rejection of claims under Section 132.

PATENTS

[4] Claims -- Broad or narrow -- In general (§ 20.201)

Reissue -- In general (§ 58.1)

Fact that claim may be broader than specific embodiment disclosed in specification is in itself of no moment; statutory provision for broadened claims in reissue applications is intended to meet precisely situation in which patentee has claimed less than he had right to claim.

PATENTS

[5] Pleading and practice in Patent Office -- In general (§ 54.1)

Specification -- Sufficiency of disclosure (§ 62.7)

35 U.S.C. 112 requires disclosure of only one mode of practicing invention; insistence upon boilerplate recitation in specification that specific embodiment shown was not meant to limit breadth of claims, or that example given was only one of several methods that could be employed, is exaltation of form over substance.

***324** Appeal from Patent and Trademark Office Board of Appeals.

Application for reissue of patent of Max Otto Henri Rasmussen, Serial No. 884,775, filed Mar. 8, 1978, for reissue of Patent No. 3,963,549, issued June 15, 1976. From decision affirming rejection of claim 6, applicant appeals. Reversed; Nies, J., dissenting.

George Vande Sande, Washington, D.C., for appellant.

Joseph F. Nakamura (Robert D. Edmonds, of counsel) for Patent and Trademark Office.

Before Markey, Chief Judge, and Rich, Baldwin, Miller, and Nies, Associate Judges.

Markey, Chief Judge.

The decision of the Patent and Trademark Office Board of Appeals (board) affirming the rejection of claim 6 under 35 USC 132 is reversed.

Background

Appealed claim 6 is contained in reissue application S.N. 884,775 filed March 8, 1978. [FN1] Original claim 6 in the reissue application was directed to a method of manufacturing a thermal insulating member. [FN2] Rasmussen described in his specification the steps of applying adhesive to one side of a tubular plastic film, winding the film around two spaced drums, and, when the desired number of layers have been wound, cutting the film layers *325 transversely to the direction of winding. When the film units are unfolded and extended, a plastic laminate in one of the forms shown below results:

Image 1 (1 X 1.75) Available for Offline Print

Viewing the particular method of adhering the layers of tubular film as immaterial, Rasmussen later amended claim 6, inter alia, by substituting "adheringly applying" for language specifying use of adhesives. [FN3]

The examiner rejected the amended claim, saying "adheringly applying" was "new matter" prohibited by §132, explaining that limitation of the scope of the original disclosure to use of adhesives meant that allowance of the broader claim would be an enlargement of the scope of the disclosure.

The board affirmed, saying Rasmussen's application disclosed only one embodiment (applying adhesive to join the sheets) and that broadening the scope of the claim added new matter to the application.

Issue

The issue presented is whether amended claim 6 was properly rejected under 35 USC 132.

Opinion

[1] Confusion is generated when related but distinct statutory provisions are treated as interchangeable. Section 132 prohibits the introduction of new matter into the disclosure of an application. Section 112,

first paragraph, requires that claim language be supported in the specification. This court, having said that a rejection of an amended claim under §132 is equivalent to a rejection under §112, first paragraph, for lack of support, appears to have contributed to the treatment of those separate statutory sections as interchangeable. See *In re Hogan*, 559 F.2d 595, 608, 194 USPQ 527, 539 (CC *326 PA 1977), *In re Wertheim*, 541 F.2d 257, 265, 191 USPQ 90, 99 (CCPA 1976), *In re Bowen*, 492 F.2d 859, 864, 181 USPQ 48, 52 (CCPA 1974), *In re Smyth*, 480 F.2d 1376, 1385, 178 USPQ 279, 286 (CCPA 1973). [FN4]

Apparently reluctant to reverse on the sole ground that an improper statutory provision had been employed, and recognizing the burden on the parties inherent in a return of the case for application of §112, this court has reviewed §132 claim rejections on the basis of whether the rejected claim found support in the original disclosure. See *In re Eickmeyer*, 602 F.2d 974, 981, 202 USPQ 655, 662 (CCPA 1979); *In re Barker*, 559 F.2d 588, 593-94, 194 USPQ 470, 474 (CCPA 1977); *In re Winkhous*, 527 F.2d 637, 640, 188 USPQ 129, 131 (CCPA 1975).

Similarly, new matter rejections of claims under §251 have been reviewed on the basis of a §112 analysis, that is, on whether a claim found support in an original patent. See *In re East*, 495 F.2d 1361, 1366, 181 USPQ 716, 719 (CCPA 1974).

As is illustrated in the present case, employment of §§ 132 and 112 as interchangeable leads to confusion of two distinct concepts: (1) the adding of new matter to the disclosure; and (2) the broadening of a claim.

[2] Broadening a claim does not add new matter to the disclosure. Disclosure is that which is taught, not that which is claimed. [FN5] An applicant is entitled to claims as broad as the prior art and his disclosure will allow.

[3] The proper basis for rejection of a claim amended to recite elements thought to be without support in the original disclosure, therefore, is §112, first paragraph, not §132. The latter section prohibits addition of new matter to the original disclosure. It is properly employed as a basis for objection to amendments to the abstract, specifications, or drawings attempting to add new disclosure to that originally presented. Past opinions of this court, in cases in which a §132 claim rejection was reviewed on a §112 analysis, should not in future be viewed as

having approved the employment of §132 as a basis for claim rejection. The amended claims involved in those cases should have been rejected under §112, first paragraph. The claim rejections in those cases could then have been explicitly affirmed or reversed on direct applications of §112, rather than on §112 analyses applied to §132 rejections. [FN6] Accordingly, such cases are overruled insofar as they approved rejection of claims under § 132.

Turning to the merits of this appeal, we will again treat a §132 claim rejection before us as though it had been made under §112, first paragraph. We proceed to decide the case on that basis in the interest of judicial economy. Were we to merely reverse the rejection as having been made under an inappropriate statutory provision, and say no more, the PTO would presumably enter a rejection under §112 and that decision would then be appealable to this court.

Amended claim 6 recites the adhering step as "adheringly applying" one layer of tube to an adjacent earlier layer. Rasmussen's specification describes that step as follows: "[A]dhesive is applied to the tubular foil 4 in a narrow or broader strip, possibly in two narrow strips. Accordingly, the face of the tubular foil successively sticks to the winding lying on the drums." The language of the specification thus describes one method of "adheringly applying" one layer to the other.

[4] As above indicated, that a claim may be broader than the specific embodiment disclosed in a specification is in itself of no moment. Indeed, the statutory provision for broadened claims in reissue applications is intended to meet precisely the situation in which a patentee has claimed "less" than he had a right to claim. 35 USC 251.

In *In re Smythe*, 480 F.2d 1376, 1384, 178 USPQ 279, 285 (CCPA 1973), this court stated:

A hypothetical situation may make our point clear. If the original specification of *327 a patent application on the scales of justice disclosed only a 1-pound "lead weight" as a counterbalance to determine the weight of a pound of flesh, we do not believe the applicant should be prevented, by the so-called "description requirement" of the first paragraph of §112, or the prohibition against new matter of §132, from later claiming the counterbalance as a "metal weight" or simply as a 1-pound "weight" although both "metal weight" and "weight" would indeed be progressively broader than "lead weight," including even such an

undisclosed, but obviously art-recognized equivalent, "weight" as a pound of feathers. The broader claim language would be permitted because the description of the use and function of the lead weight as a scale counterbalance in the whole disclosure would immediately convey to any person skilled in the scale art the knowledge that the applicant invented a scale with a 1-pound counterbalance weight, regardless of its composition.

[5] Similarly, one skilled in the art who read Rasmussen's specification would understand that it is unimportant how the layers are adhered, so long as they are adhered. [FN7] Thus the phrase "adheringly applying" is supported by the example found in the specification.

Conclusion

The phrase "adheringly applying" being supported in the specification, rejection of that claim under 35 USC 132, first paragraph, is reversed. Rejection under the appropriate statutory provision, 35 USC 112, would have been inappropriate.

Reversed

FN1 That application seeks reissue of U.S. Patent 3,963,549, issued June 15, 1976.

FN2 6. A method of manufacturing a thermal insulating member from a thin film of plastic material and comprising a pair of spaced opposing generally parallel sidewalls which are bridged by a plurality of spaced transverse walls comprising the steps of:

winding a continuous length of a tube formed of the plastic material in its flattened state into a generally cylindrical member whose circumference corresponds to the desired width of the insulating member,

applying to the flattened tube a band of adhesive of predetermined width corresponding substantially to the width of said spaced transverse walls and thus to the desired spacing between the sidewalls, said application of adhesive occurring prior to the contacting of the flattened tube during the winding step to the portion of the tube already wound onto the cylindrical member so that successive layers of said tubular member on said cylindrical member adhere to each other along the predetermined width of adhesive application,

terminating the winding of the plastic tube onto the

cylindrical member when a predetermined number of layers of the plastic tube has been wound thereon corresponding to the desired length of the thermal insulating member,

and cutting the superimposed assemblage of successively adhering layers of the plastic tube in a direction transverse to the longitudinal direction of the tube,

said assemblage when longitudinally straightened and then extended in a direction transverse to the longitudinal direction of the tube so as to expand the successively joined tubes forming said thermal insulating member. [Emphasis added.]

FN3 Amended claim 6 reads as follows:

6. A method of manufacturing a thermal insulating member from a thin film of material and comprising a pair of spaced opposing generally parallel sidewalls which are bridged by a plurality of spaced transverse walls comprising the steps of:

winding a continuous length of a tube formed of the material in its flattened state onto a generally cylindrical member whose circumference corresponds to the desired width of the insulating member, each successive layer of said tube being wound to overlie the immediately preceding layer to provide thereby a generally cylindrical band of tubular layers extending axially along said cylindrical member a distance corresponding substantially to the flattened width of said tube,

adheringly applying the flattened tube during the winding step to the portion of the tube already wound onto the cylindrical member over a band of predetermined width corresponding substantially to the desired width of said spaced transverse walls and thus to the desired spacing between said sidewalls,

terminating the winding of the tube onto the cylindrical member when a predetermined number of layers of the tube has been wound thereon corresponding to the desired length of the thermal

insulating member,

and cutting the superimposed assemblage of successively adhering layers of the tube in a direction transverse to the longitudinal direction of the tube,

said assemblage when longitudinally straightened and then extended in a direction transverse to the longitudinal direction of the tube so as to expand the successively joined tubes forming said thermal insulating member. [Emphasis added.]

FN4 MPEP 706.03(o), 608.04-608.04(c), and 1411.02 relate to considerations set forth herein.

FN5 We deal here with rejection of amended claims, and, by implication, with rejection of entire new claims submitted after filing. An original claim is part of the disclosure at the time of filing. In re Anderson, 471 F.2d 1237, 1238, 176 USPQ 331, 332 (CCPA 1973). Consideration of an original claim as evidencing support in the disclosure for later submitted claims does not warrant employment of § 132 as a basis for rejection of later submitted claims on the ground that the latter are adding new matter to the original claim portion of the disclosure. To so hold would render § 132 redundant in light of §112, first paragraph.

FN6 Similarly, rejections of claims for lack of support when required in reissue applications should be made under §112, first paragraph, rather than under the new matter prohibition of 35 USC 251.

FN7 The board seemed to realize that 35 USC 112 requires disclosure of only one mode of practicing the invention, but nevertheless insisted upon a boilerplate recitation in the specification that the specific embodiment shown was not meant to limit the breadth of the claims, or that the example given was only one of several methods which could be employed. Such insistence is here an exaltation of form over substance.

Cust. & Pat.App.

211 U.S.P.Q. 323

END OF DOCUMENT

Appendix 14:

In re Zurko, 258 F.3d 1379, 59 U.S.P.Q.2d 1693 (Fed. Cir. 2001).

In re Zurko

U.S. Court of Appeals Federal Circuit

No. 96-1258

Decided August 2, 2001

PATENTS

[1] Patentability/Validity -- Obviousness -- Combining references (§ 115.0905)

JUDICIAL PRACTICE AND PROCEDURE

Procedure -- Judicial review -- Standard of review -- Patents (§ 410.4607.09)

Decision of Board of Patent Appeals and Interferences sustaining obviousness rejection of patent application for method of improving security in computer system is reversed, even though board's factual findings underlying its determination are reviewed under "substantial evidence" standard, since prior art references relied upon by board do not teach limitation requiring communications between user and "trusted" environment along "trusted" path, and since deficiencies of references cannot be remedied by reliance upon additional combination of alternative references cited for first time on appeal, or by board's general conclusion, unsupported by evidence in record, that requiring communication with trusted environment over trusted path would be "basic knowledge" or "common sense" to person of ordinary skill in art; although board's expertise alone may provide sufficient support for conclusions as to peripheral issues, its core factual findings in patentability determinations must be supported by concrete evidence in record.

On remand from the U.S. Supreme Court.

Patent application of Mary E. Zurko, Thomas A. Casey Jr., Morie Gasser, Judith S. Hall, Clifford E. Kahn, Andrew H. Mason, Paul D. Sawyer, Leslie R. Kendall, and Steven B. Lipner, serial no. 07/479,666 (method for improving security in a computer system). Board of Patent Appeals and Interferences sustained examiner's rejection of application under 35 U.S.C. § 103. The U.S. Court of Appeals***1694** for the Federal Circuit reversed on appeal (42 USPQ2d 1476). On rehearing en banc, the Federal Circuit held (46 USPQ2d 1691) that proper standard of review for fact findings underlying patentability determinations by Patent and Trademark Office is "clearly erroneous" standard, rather than more deferential standard found

in Administrative Procedure Act. The U.S. Supreme Court reversed the Federal Circuit's en banc decision and remanded, holding (50 USPQ2d 1930) that PTO's findings of fact must be reviewed under either "substantial evidence" or "arbitrary and capricious" APA standards of review. On remand, the Federal Circuit again reverses board's decision.

Linda Moncys Isacson, associate solicitor, John M. Whealan, solicitor, and Kenneth R. Corsello and Thomas J. Finn, associate solicitors, U.S. Patent and Trademark Office, Arlington, Va., for Commissioner of Patents and Trademarks.

John F. Sweeney, Michael O. Cummings, Jon T. Hohenthanner, Israel Blum, Steven F. Meyer, and Brenda Pomerance, of Morgan & Finnegan, New York, N.Y.; Irene Kosturakis and Russell T. Wong, of Compaq Computer Corp., Houston, Texas; Ernest Gellhorn, Washington, D.C.; Janice M. Mueller, of Suffolk University Law School, Boston Mass.; Ronald C. Hudgens, of Digital Equipment Corp., Maynard, Mass., for Mary E. Zurko et al.

Before Newman, circuit judge, Archer, senior circuit judge, and Michel, circuit judge.

Archer, S.J.

This case is before us on remand from the Supreme Court of the United States. *Dickinson v. Zurko*, 527 U.S. 150, 50 USPQ2d 1930 (1999) (" *Zurko III*"). In *Zurko III*, the Court reversed our judgment and remanded the case because we had reviewed the factual findings of the Board of Patent Appeals and Interferences ("Board") for clear error, an incorrect standard of review.

The Board decision at issue, *Ex parte Zurko*, No. 94-3967 (Bd. Pat. Apps. & Int. Aug. 4, 1995), sustained the rejection of U.S. Patent Application No. 07/479,666 ("the '666 application") under 35 U.S.C. § 103 (1994). In our initial review of this decision, we determined that the Board's findings were clearly erroneous and we reversed. *In re Zurko*, 111 F.3d 887, 42 USPQ2d 1476 (Fed. Cir. 1997) (" *Zurko I*"). At the Commissioner's suggestion, we then reheard this case en banc to reconsider the question of the appropriate standard of review. The Commissioner argued that Board findings should be reviewed under the standards of the Administrative Procedure Act (APA), namely the substantial evidence or arbitrary and capricious

standard. 5 U.S.C. § 706 (1994). The en banc court held, however, that clear error was the correct standard of review for Board findings of fact and adopted the conclusions of the original panel decision. In re Zurko, 142 F.3d 1447, 46 USPQ2d 1691 (Fed. Cir. 1998) ("Zurko II").

The Commissioner then petitioned for review by the Supreme Court, and the Court reversed, holding that Board findings of fact must be reviewed under the APA standards of review. The Court did not specify which APA standard of review to apply, substantial evidence or arbitrary and capricious. We subsequently decided this question in In re Gartside, 203 F.3d 1305, 53 USPQ2d 1769 (Fed. Cir. 2000), and held that substantial evidence is the correct APA standard of review for Board factual findings.

We now revisit the merits of our decision in Zurko I, applying the proper APA standard of review. In doing so, we conclude that the outcome of this case does not change with the application of this new standard of review. Because the factual findings underlying the Board's decision are not supported by substantial evidence, we reverse.

BACKGROUND

The '666 application concerns a method for more efficiently creating a secure computer environment. Secure, or "trusted," computer environments employ trusted software designed to preclude unauthorized users and to prevent unintended or unauthorized commands. Such trusted software is often quite costly, compared to untrusted software, so it is desirable to minimize the amount of trusted software in the system. Applicants claim a method for processing trusted commands with a minimum of trusted software.

Representative claim one reads as follows:

1. A machine-executed method for executing a trusted command issued by a user on a computer system, the computer system including an untrusted computing environment and a trusted computing environment, said method comprising the steps of:

***1695** (a) parsing the trusted command in the untrusted computing environment to generate a parsed command;

(b) submitting the parsed command to the trusted computing environment;

(c) displaying a representation of the trusted command to the user through a trusted path;

(d) receiving a signal from the user through a trusted path signifying whether the displayed representation accurately represents the user's intentions;

(e) if the signal signifies that the displayed representation does not accurately represent the user's intentions, then preventing the execution of the parsed command;

(f) if the signal signifies that the displayed representation accurately represents the users intentions, executing the parsed command in the trusted environment.

As set forth in claim one, applicants' method involves processing and verifying a trusted command using both trusted and untrusted software. A trusted command is first processed by untrusted software to create a parsed command. The parsed command is then submitted to the trusted computer environment. Execution of this command requires verification along a trusted path. The parsed command is relayed to the user along a trusted path, and, if correct, the user can send a confirming signal back along this trusted path, allowing execution of the command. By processing a trusted command in this manner, the applicants contend they reduce the amount of trusted software. The applicants assert that the parsing step generally requires a large amount of software and that performing this step with untrusted software greatly reduces the amount of trusted code required to process a trusted command.

The Board sustained the Examiner's rejection of claims 1, 4, and 5 of the '666 application under 35 U.S.C. § 103 based on two prior art references. The primary reference is the UNIX operating system, as described in the applicants' information disclosure statement ("IDS"). According to this description, the UNIX system employs both untrusted and trusted code. Furthermore, certain commands in a UNIX system may be parsed in an untrusted environment, and then these parsed commands may be executed by "calling a trusted service that executes in a trusted computing environment."

The secondary reference, also described in applicants' IDS, is Dunford, FILER Version 2.20 ("FILER2"). This program repeats back potentially dangerous commands, requesting confirmation from the user before execution.

Considering the teachings of these two references, the Board concluded that the invention claimed by the '666 application would have been obvious. The Board commented that "the artisan would have been led from these teachings to take the trusted command parsed in an untrusted environment and submitted to the trusted computing environment, as taught by UNIX, and to display the parsed command to the user for confirmation prior to execution, as suggested by [FILER2]." *Ex parte Zurko*, slip op. at 6-7. According to the Board, this combination would render the claimed invention obvious.

The Board also responded to applicants' arguments that neither reference discloses a trusted path communication to the user and that no teaching of the prior art references motivates the combination of these references to create the claimed invention. The Board said that communication along a trusted path, if not explicit in the prior art, is either inherent or implicit. *Id.* at 7. The Board further adopted the Examiner's assertion that "it is basic knowledge that communication in trusted environments is performed over trusted paths." *Id.* at 8. As for the motivation to combine these references, the Board concluded that it "would have been nothing more than good common sense" to combine the teachings of these references. *Id.* The Board noted that FILER2 taught the verification of dangerous commands in general, suggesting verification of the parsed command submitted to the trusted computing environment in UNIX. Because this verification occurs within a trusted environment, it is "basic knowledge," according to the Board, that this verification would occur along a trusted path. *Id.* at 7-8.

Reviewing the Board's decision in *Zurko I*, we held that "the Board's finding that the prior art teaches, either explicitly or inherently, the step of obtaining confirmation over a trusted pathway [was] clearly erroneous." *Zurko I*, 111 F.3d at 889, 42 USPQ2d at 1478. Indeed, we noted that neither reference relied upon by the Board taught communication with the *1696 user over a trusted pathway. *Id.*, 42 USPQ2d at 1479. We further held that the Board clearly erred in finding that the prior art teaches communicating with the user over both a trusted and an untrusted path. This finding was in conflict with the Board's other finding that trusted communications must be over trusted paths. *Id.* at 890, 42 USPQ2d at 1479.

On remand, applicants urge that we maintain our reversal of the Board's decision, arguing that the decision is legally flawed, or, alternatively, that the

Board's factual findings fail under the APA standard of review. The Commissioner responds that we must affirm the Board decision because its findings are supported by substantial evidence in the record.

DISCUSSION

A claimed invention is unpatentable for obviousness if the differences between it and the prior art "are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art." 35 U.S.C. § 103(a) (1994); *Graham v. John Deere Co.*, 383 U.S. 1, 14, 148 USPQ 459, 465 (1966). Obviousness is a legal question based on underlying factual determinations including: (1) the scope and content of the prior art, including what that prior art teaches explicitly and inherently; (2) the level of ordinary skill in the prior art; (3) the differences between the claimed invention and the prior art; and (4) objective evidence of nonobviousness. *Graham*, 383 U.S. at 17-18, 148 USPQ at 467; *In re Dembiczak*, 175 F.3d 994, 998, 50 USPQ 1614, 1616 (Fed. Cir. 1999); *In re Napier*, 55 F.3d 610, 613, 34 USPQ2d 1782, 1784 (Fed. Cir. 1995) (stating that the inherent teachings of a prior art reference is a question of fact). We review the ultimate legal determination of obviousness without deference. *In re Dembiczak*, 175 F.3d at 998, 50 USPQ at 1616. We review factual findings underlying this determination for substantial evidence. *In re Gartside*, 203 F.3d at 1311-16, 53 USPQ2d at 1772-75.

Substantial evidence is "such relevant evidence as a reasonable mind might accept as adequate to support a conclusion." *Consol. Edison Co. v. NLRB*, 305 U.S. 197, 229 (1938); see also *Zurko III*, 527 U.S. at 162, 50 USPQ2d at 1772-75. A review under this standard "involves an examination of the record as a whole, taking into consideration evidence that both justifies and detracts from the agency's decision." *In re Gartside*, 203 F.3d at 1312, 53 USPQ2d at 1773 (citing *Universal Camera Corp. v. NLRB*, 340 U.S. 474, 487-88 (1951)). In addition, "the possibility of drawing two inconsistent conclusions from the evidence does not prevent an administrative agency's finding from being supported by substantial evidence." *Consolo v. Fed. Maritime Comm'n*, 383 U.S. 607, 619-20 (1966).

The substantial evidence standard has been analogized to the review of jury findings, and it is generally considered to be more deferential than the clearly erroneous standard of review. *Zurko III*, 527 U.S. at 162-63, 50 USPQ2d at 1936. The Supreme Court noted in *Zurko III*, however, that this generally

recognized difference is "a subtle one," so fine that in its review of case law in the *Zurko III* decision, the Court could not find any other case where a reviewing court had conceded that the standard of review made a difference. *Id.* Moreover, while appellate courts must respect agency expertise, the Court has "stressed the importance of not simply rubber-stamping agency fact finding." *Id.* (citing *Universal Camera*, 340 U.S. at 477-78). Indeed, the Court observed that Federal Circuit judges "will examine [Board fact] findings through the lens of patent-related experience -- and properly so, for the Federal Circuit is a specialized Court." *Id.* The Court further noted that this "comparative expertise, by enabling the Circuit better to understand the basis for the [Board's] finding of fact, may play a more important role in assuring proper review than would a theoretically somewhat stricter standard." *Id.*

With this guidance from the Supreme Court in mind, we now reconsider the Board's decision. Applicants urge that we reaffirm our conclusion in *Zurko I*, alleging numerous legal and factual errors in the Board decision. These arguments center around two issues. First, applicants argue that the prior art relied upon by the Board does not disclose one of the limitations of their claimed invention, namely communication between a trusted environment and the user along a trusted path. Second, applicants claim that there is no substantial evidence support for the Board's finding of motivation to combine the cited references to yield the claimed invention. We only need to consider the first issue raised by applicants.

[1] As to this first issue, the Commissioner apparently concedes that neither the UNIX IDS disclosure nor FILER2 teaches communications between the user and the trusted environment along a trusted path. Nevertheless, the Commissioner maintains that the Board's findings concerning the content of the prior art are supported by four other references in the record. [FN1] The Commissioner argues that these additional references describe modified UNIX systems that allow communication over both trusted and untrusted paths. Therefore, the Commissioner argues, the Board's general findings concerning the content of the prior art have substantial evidence support, as does its ultimate conclusion of obviousness.

We are unpersuaded by the Commissioner's arguments. The Board's conclusion of obviousness was based on the UNIX and FILER2 references. The Board's findings with respect to these references

simply cannot be supported by the alternative references identified by the Commissioner on remand. To the contrary, these alternative references merely confirm the well-known fact that conventional UNIX systems do not allow communication between the user and the trusted environment along a trusted path. For example, *Johrie et al.*, U.S. Pat. No. 4,918,653, comments that "[s]ome examples of prior art multi-user operating systems which have not provided an effective mechanism for establishing a trusted path include UNIX" *Johrie*, col. 1, II. 60-63.

The Commissioner also cannot now mend the Board's faulty conclusion of obviousness by substituting these alternative references for those relied upon by the Board. This new combination of references would constitute a new ground for rejection, not considered or relied upon by the Examiner or the Board. It is well settled that it would be inappropriate for us to consider such a new ground of rejection. In *re Margolis*, 785 F.2d 1029, 1032; 228 USPQ 940, 942 (Fed. Cir. 1986) ; see also *Koyo Seiko Co., Ltd. v. United States*, 95 F.3d 1094, 1099 (Fed. Cir. 1996) (holding that "[t]he grounds upon which an administrative order must be judged are those upon which the record discloses that its action was based.") (quoting *SEC v. Chenery Corp.*, 318 U.S. 80, 87 (1943)).

Finally, the deficiencies of the cited references cannot be remedied by the Board's general conclusions about what is "basic knowledge" or "common sense" to one of ordinary skill in the art. As described above, the Board contended that even if the cited UNIX and FILER2 references did not disclose a trusted path, "it is basic knowledge that communication in trusted environments is performed over trusted paths" and, moreover, verifying the trusted command in UNIX over a trusted path is "nothing more than good common sense." *Ex parte Zurko*, slip op. at 8. We cannot accept these findings by the Board. This assessment of basic knowledge and common sense was not based on any evidence in the record and, therefore, lacks substantial evidence support. As an administrative tribunal, the Board clearly has expertise in the subject matter over which it exercises jurisdiction. This expertise may provide sufficient support for conclusions as to peripheral issues. With respect to core factual findings in a determination of patentability, however, the Board cannot simply reach conclusions based on its own understanding or experience -- or on its assessment of what would be basic knowledge or common sense. Rather, the Board must point to some concrete evidence in the record in support of these findings. [FN 2] To hold otherwise

would render the process of appellate review for substantial evidence on the record a meaningless exercise. *Baltimore & Ohio R.R. Co. v. Aderdeen & Rockfish R.R. Co.*, 393 U.S. 87, 91-92 (1968) (rejecting a determination of the Interstate Commerce Commission with no support in the record, noting that if the Court were to conclude otherwise "[t]he requirement for administrative decisions based on substantial evidence and reasoned findings -- which alone make effective judicial review possible -- *1698 would become lost in the haze of so-called expertise"). Accordingly, we cannot accept the Board's unsupported assessment of the prior art.

CONCLUSION

The Board's conclusion of obviousness was based on a misreading of the references relied upon and, therefore, lacks substantial evidence support. Accordingly, the Board's judgment is reversed.

REVERSED.

FN1. Specifically, the Commissioner points to Johrie et al., U.S. Pat. No. 4,918,653; E.J. McCauley et al., *KSOS: The Design of a Secure Operating System*, Ford Aerospace and Communications Corp. (1979); Stanley R. Ames, Jr. et al., *Security Kernel Design and Implementation: An Introduction*, IEEE Cat. No. 830700-001 (July 1983); and Simon Wiseman et al., *The Trusted Path Between Smite and the User*, Proceedings 1988 IEEE Symposium on Security and Privacy (April 18-21, 1988).

FN2. As described above, we cannot accept the Commissioner's invitation to now search the record for references in support of the Board's general conclusions concerning the prior art. Even if any such references could support these conclusions, it would be inappropriate for us to consider references not relied upon by the Board. *In re Margolis*, 785 F.2d at 1032; 228 USPQ at 942.

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59 U.S.P.Q.2D 1693

END OF DOCUMENT

Appendix 15:

In re Heyl, 379 F.2d 1018, 154 U.S.P.Q 178 (C.C.P.A. 1967)

In re Heyl

Court of Customs and Patent Appeals

Appl. No. 7881

Decided June 29, 1967

Rehearing denied Oct. 5, 1967

United States Patents Quarterly Headnotes

PATENTS

[1] Board of Appeals-Procedure after hearing or decision (§ 19.40)

Disclaimer-Time to disclaim (§ 32.8)

Neither *In re Tanner*, 145 USPQ 345, nor *In re Dunn*, 146 USPQ 479, was intended to preclude establishment of orderly procedures for consideration of terminal disclaimers in Patent Office; thus, it is proper for Board to refuse to consider effect of terminal disclaimer filed after Board's affirmance of rejection.

PATENTS

[2] Court of Customs and Patent Appeals-Issues determined-Ex parte patent cases (§ 28.203)

Court declines to consider solicitor's argument for unpatentability of claims since his contention that claims are not readable on disclosure seems to be no more than an ill-disguised rejection for lack of support, quite distinct from double patenting rejection made by examiner and Board.

PATENTS

[3] Double patenting-Tests of (§ 33.9)

Double patenting rejection is good since, even if claims of application and of patent define separate inventions, one is no more than obvious variant of the other; court cannot be bound by allowance of patent claims as indicative of necessary patentable distinction.

PATENTS

Particular patents-Closure

Heyl, Closure for Bottles and Other Containers, claims 30 to 35 and 40 to 46 of application refused.

***179** Appeal from Board of Appeals of the Patent Office.

Application for patent of Edgar G. Heyl, Serial No. 505,415, filed May 2, 1955; Patent Office Group 170. From decision rejecting claims 30 to 35 and 40 to 46,

applicant appeals. Affirmed.

Alvin Gutttag, Washington, D. C. (C. Edward Parker, Spartanburg, S. C., of counsel) for appellant.

Joseph Schimmel (George C. Roeming of counsel) for Commissioner of Patents.

Before Worley, Chief Judge, and Rich, Smith, and Almond, Associate Judges.

Rich, Judge.

This appeal is from the decision of the Patent Office Board of Appeals, adhered to on reconsideration, affirming the rejection of claims 30-35 and 40- 46 in application serial No. 505,415, filed May 2, 1955, entitled "Closure for Bottles and Other Containers." A rejection of claims 36-39 was also affirmed but appeal from that decision has been withdrawn. No claim has been allowed.

The Claimed Invention

The invention is a method for the formation of a closure at the opening in a container (e.g., at the top of a bottle) in which a sheet of polymer is placed over and around the opening and then heat shrunk to form the closure. Claims are directed to the closure itself, the method, and apparatus. The following are illustrative:

30. A method of forming a closure having a central portion and a skirt for containers from a heat shrinkable polymer and applying the same to said containers comprising placing a sheet of said polymer over the top of a container, forming from said sheet a cover portion thereof of an area to overlie the open end of the container and to have an edge portion extending downwardly over the lip of the container to form a skirt there-around, and applying heat to the skirt portion of said sheet whereby the heated area of the skirt portion will shrink and snugly fit the coextensive external area of the container.

34. A closure having a central portion and a skirt for containers made of a heat shrinkable plastic material, said closure being relatively thin and in substantially unshrunk condition over the major area of the central portion thereof, said closure terminating in a substantially shrunk skirt which, when in closing relation with a container, snugly

fits the coextensive area of the container.

40. An apparatus for shaping and shrinking shrinkable film comprising means for simultaneously holding said film in place on an object, and for folding the edges of the film down and means for heating said folded edges to shrink the same while the balance of the film is held in place.

Claims 31 and 32 are dependent on claim 30 and are limited to closures which include biaxially oriented polyethylene and a laminate of that polyethylene and shrinkable polyethylene terephthalate, respectively. Claims 33 and 46 are similar to claim 30.

Claim 42 is dependent on claim 30 and specifies a shrinkable polymer of an ester of terephthalic acid and a glycol having 2 to 10 carbon atoms. Claim 43 is dependent on claim 42 and specifies an ester of polyethylene terephthalate. Claim 44 is also dependent on claim 42 and requires that the container be filled before sealing and that the contents be subsequently heat treated.

Claim 35 is directed to the combination of container and closure, the latter being described in language similar to that of claim 34. Claim 41 is dependent on claim 35 and is limited to closures of heat shrinkable polyethylene terephthalate and containers of pressure beverages.

The Rejections

The following references were relied on:

Engels 825,116 July 3, 1906

Dreyfus et al. 2,976,655 Mar. 28, 1961

***180** Engels discloses a plastic, heat shrinkable closure which, like appellant's, is made up of a central part and a skirt. The skirt is shown in several of the drawings as heat shrunk about the part of a container adjacent the covered opening. Engels' examples disclose celluloid as the plastic.

Dreyfus et al. is assigned to W. R. Grace and Co., owners of appellant's application. It contains, inter alia, the following claims:

1. A method of forming a cover having an elastic edge comprising positioning a film of a high shrink energy polymer over and beyond the lip of a container, maintaining pressure on the film over the

container, forcing the excess film downwardly around the container to form a gathered skirt and heating a band of said skirt briefly to shrink the skirt and provide a gathered but relatively elastic edge.

2. A method according to claim 1 wherein the polymer is irradiated, biaxially oriented polyethylene.

3. A machine for forming covers made of a heat shrinkable material on a dish shaped container comprising a container support, means for maintaining a film cover on a container positioned on said support and for gathering the edge of the film extending beyond the edge of the dish into a downwardly depending skirt and impulse heat sealing [means] positioned adjacent said support so as to heat shrink the gathered edge of said film.

The examiner rejected closure claims 34, 35, and 41 as obvious in view of Engels under 35 U.S.C. 103. The specification of heat shrinkable polyethylene terephthalate in claim 41 did not, in the examiner's opinion, impart patentability since "such a film is admittedly old as noted from * * * the specification. Accordingly, to substitute heat shrinkable polyethylene terephthalate for the heat shrinkable celluloid employed by Engels would be obvious." The limitation to use with a pressure beverage he deemed an obvious expedient.

The examiner rejected method claims 30-33 and 42-46 for double patenting in view of claims 1 and 2 of Dreyfus et al. He seemed to think that appellant's claims were drawn to the same invention as those of the patent. He also argued that the same "inventive concept" was involved in each set of claims. He also thought obvious the additional limitations of claims 44 and 45.

He rejected claim 40, the apparatus claim, for double patenting in view of claim 3 of Dreyfus et al. The recitation of impulse heat sealing means in the patent claim did not, in the examiner's opinion "render the rejection improper" since claim 40 "is clearly readable on claim 3 of Dreyfus et al. and would extend the monopoly." He also cited *In re Christensen*, 51 CCPA 1236, 330 F.2d 652, 141 USPQ 295 (1964).

The board, in a concise opinion, affirmed the examiner's rejections. Claims 34, 35, 40, and 41 were treated in an especially pithy fashion:

With regard to the rejection of claims 34, 35, 40 and 41 *supra*, in our opinion the reasons for the rejection as set forth in the Examiner's Answer are considered sound. We perceive no compelling reasons in appellant's arguments for holding otherwise.

The other rejections were approved since "the gist of the invention is the same in both cases."

Appellant then filed a terminal disclaimer and requested reconsideration by the board. In an opinion refusing to make any change, the board commented thus on the disclaimer:

It is not the practice of the Board to consider a terminal disclaimer filed after the Board's decision since to do so would amount to a reopening of the prosecution which is contrary to Rule 198. However, in passing, we note the terminal disclaimer does not appear to be appropriate in this application in view of the overlapping relationship of the claims of the application and the patent, pointed out in our original decision. Hence, the overlapping relationship herein which, we note, was not present in *In re Robeson*, 141 USPQ 485, and *In re Kaye*, 141 USPQ 829, could result in multiple harassment of the public. Moreover, the *Robeson* and *Kaye* decisions have not been extended to cover cases of different inventors with a common assignee. [Emphasis ours.]

The board also addressed itself to the following statement in appellant's petition:

In regard to apparatus claim 40 in particular, it is pointed out that the Board has ignored the express limitations in claim 3 of Dreyfus to impulse heat sealing means. Such means, not being disclosed in Heyl, obviously could not be claimed in Heyl, and it is submitted that Heyl is properly *181 entitled to the generic apparatus claim.

The board felt that the additional limitation did not create the necessary patentable distinction, applying the test of *In re Christensen*, *supra*, in which we said, 141 USPQ at 297:

* * * the correct procedure for double patenting cases is to analyze the claims to determine the inventions defined therein, and then decide whether such inventions, as claimed, are patentably distinct and therefore qualified to be claimed in separate patents.

The solicitor has taken an entirely different approach toward the double- patenting rejection of the method claims. He argues, in his brief, that claims 30-33 and 42-46 "are not supported by and not readable on appellant's original disclosure." It then follows, according to the solicitor, as we understand his argument, that the later-filed Dreyfus et al. patent is prior art with respect to those claims since they were entered in their present form after the patent's filing date. See 35 U.S.C. 102(e); *Muncie Gear Works, Inc. v. Outboard, Marine & Mfg. Co.*, 315 U.S. 759, 53 USPQ 1 (1942). The solicitor's brief summarizes:

Since Dreyfus et al. with respect to appellant were clearly the first and only applicants to disclose the subject matter of claims 30 through 33 and 42 through 46, their disclosure under 35 U.S.C. 102(e) and (g) anticipates those claims in appellant's application and such anticipation cannot be overcome by a terminal disclaimer.

The solicitor undertook "no amplification" of the reasons of the examiner and board for the rejection of claim 40. He argued that the invention of claims 34, 35, and 41 is described as well in Engels, at least, as in appellant's application.

We will discuss separately the double-patenting rejection of claims 30-33 and 42-46, the double-patenting rejection of claim 40, and the prior art rejection of claims 34, 35, and 41. We will set forth the pertinent parts of appellant's arguments in each discussion as we comment on them. We will first, however, dispose of the problem of whether the terminal disclaimer can be considered.

The Terminal Disclaimer

[1] Appellant argues that the board's refusal to consider his terminal disclaimer deliberately flouts this court's direction in *In re Tanner*, 52 CCPA 1307, 343 F.2d 1018, 145 USPQ 345 (1965), a decision several months earlier than the board's refusal here. We do not agree. We remanded that case to the board to consider the effect of a terminal disclaimer filed after appeal in the light of decisions of this court clarifying the law subsequent to the board's action. Those same decisions were several months prior to the board decision here. See also *In re Dunn*, 52 CCPA 1760, 349 F.2d 433, 146 USPQ 479 (1965). We, of course, did not mean by those exceptional actions, taken in the interest of justice, to preclude the establishment of orderly procedures for the consideration of terminal disclaimers in the

Patent Office. We interpret the board's decision in this case as a refusal to consider the effect of the disclaimer because of its untimely submission. It does not appear that any of our later decisions would affect the propriety of that refusal. We, therefore, will not disturb it. [FN1] Cf. *In re Pantzer*, 52 CCPA 1135, 341 F.2d 121, 144 USPQ 415 (1965); *In re Harris*, 51 CCPA 786, 324 F.2d 316, 139 USPQ 292 (1963). We therefore decide the case on the basis that there is no terminal disclaimer for our consideration.

The Double Patenting Rejection of Claims 30-33 and 42-46

[2] The solicitor's argument for the unpatentability of these claims seems to us no more than an ill-disguised rejection for lack of support, quite distinct from that for double patenting made below. We decline to consider it. *In re Baird*, 52 CCPA 1747, 348 F.2d 974, 146 USPQ 579 (1965); *In re Sutherland*, 52 CCPA 1683, 347 F.2d 1009, 146 USPQ 485 (1965).

[3] Appellant relies primarily on the limitation in the *Dreyfus et al.* claims to the effect that "a band" (of indeterminate width) of the skirt must be heated. He argues that his claims require the entire skirt to be heated and are thus patentably distinct from those of the patent. He recognizes, as he must, that his claims are not so limited in terms. He attempts, however, to read into them the limitations of his examples. *182 Inasmuch as there is no terminal disclaimer before us, we do not feel that it is necessary to decide whether this effort is successful. It seems to us, as it did to the examiner, that even if the claims here in question define separate inventions by reason of the reading in of the example limitations, one is no more than an obvious variant of the other. In such a case, of course, the double patenting rejection is good. *In re Zickendraht*, 50 CCPA 1529, 319 F.2d 225, 138 USPQ 22 (1963); see *In re Robeson*, 51 CCPA 1271, 331 F.2d 610, 141 USPQ 485 (1964); *In re Kaye*, 51 CCPA 1465, 332 F.2d 816, 141 USPQ 829 (1964).

A contention that there are unobvious differences between the claims of the patent and the application seems implicit in appellant's frequent assertion of patentable distinction. The details of his argument, however, seem to focus almost solely on establishing the separateness of the inventions. And this, of course, is not enough. Appellant has pointed to the allowance of the *Dreyfus et al.* claims as indicative of the necessary patentable distinction; but we cannot be bound thereby.

Appellant does urge that unobviousness is imparted by the specification of two-ply laminate in claim 32 and of polyethylene terephthalate in claims 44 and 45 and, even, by the specification of a pressure-containing beverage in claim 45 and the heating of the contents of the container specified in claims 44 and 45. We cannot agree. Limitations of the invention of the patent claims to use in a conventional way or with plastic material of admittedly known desirable qualities are not unobvious limitations. Nor could we ignore, on the mere contrary assertion of appellant, the examiner's persuasive statement that the laminate might obviously be substituted for the film of a single layer.

The Double Patenting Rejection of Claim 40

There is some ambiguity in the explanation of this rejection by both examiner and board. However, we think that their reliance on *In re Christensen*, *supra*, shows that neither meant to assert that the mere dominance of the claims in the application over those of the reference patent requires a double patenting rejection. See *In re Stanley*, 41 CCPA 956, 214 F.2d 151, 102 USPQ 234 (1954). We think rather, that they found no unobvious distinction between the claims—between the generic heating means and the specific "impulse" heat sealing means. Appellant's argument again seems either to assume unobviousness or to ignore its necessity. He argues:

The examiner and Board have now advanced the novel proposition that even though a species invention is admittedly patentable over a prior generic invention that the owner of both the genus invention and the species invention cannot obtain a patent on the earlier filed genus invention once the specific invention issue[s] into a patent.

We do not think we have before us the case appellant describes. Appellant's inability to claim the specific heating means of *Dreyfus et al.* is, of course, not determinative of the unobviousness question.

The Prior Art Rejection of Claims 34, 35, and 41

Appellant's short argument against the prior art rejection is based on his contention that the central part of Engels' closure would not be in an unshrunk condition. Appellant's claims require an unshrunk and relatively thin central portion of the closure. Appellant compares the steps in his formation of the closure with those of Engels to show the necessity of the differences, neither disclosure being explicit. We

(Cite as: 154 U.S.P.Q. 178, *182)

think, however, that the examiner correctly pointed out that these arguments would be more in point were method claims here involved. This rejection is under 35 U.S.C. 103. Whether or not Engels anticipates appellant's closure, it seems to us that unobviousness cannot be predicated on apparently immaterial differences in thickness of the plastic material. We likewise agree with the examiner's disposal of appellant's other arguments relying on the particular plastics, use with "pressure beverages," etc., as obvious expedients.

The decision of the board is affirmed.

SMITH, Judge, took no part in the decision of this

case.

FN1 Our action should not be taken to indicate approval of the board's comments on the effect of the "overlapping relationship of the claims" and the different inventorship of the applications. See *In re Braithwaite*, 54 CCPA 1589, 379 F.2d 594, 154 USPQ 29; *In re Bowers*, 53 CCPA 1590, 359 F.2d 886, 149 USPQ 570 (1966).

Cust. & Pat.App.

154 U.S.P.Q. 178

END OF DOCUMENT

Appendix 16:

Crown Operations Intl. v. Solutia, Inc., 289 F.3d 1367, 62 U.S.P.Q.2d 1917 (Fed.
Cir. 2002)

H

Crown Operations International Ltd.

v.

Solutia Inc.

U.S. Court of Appeals Federal Circuit

No. 01-1144

Decided May 13, 2002

PATENTS

[1] Patentability/Validity -- Anticipation -- Prior art (§ 115.0703)

Patentability/Validity -- Obviousness -- Relevant prior art -- In general (§ 115.0903.01)

Patent directed to solar and safety control glass with minimal visual distortion is not anticipated by prior art patent, since invention addresses visual distortion problem by limiting visible reflectance contribution of solar control film layer to no more than about 2 percent, whereas prior patent does not discuss or disclose 2 percent limitation, since prior reference will not be assumed to inherently contain claimed property merely because it discloses same structure, and since declaratory plaintiff has not presented sufficient evidence to rebut presumption of validity and defendant's facial evidence that prior patent does not disclose 2 percent limitation; patent is not obvious in light of prior art, since plaintiff has not shown that prior art contains teaching, suggestion, or motivation to reduce reflectance contribution to about 2 percent.

[2] Patentability/Validity -- Specification -- Enablement (§ 115.1105)

Genuine issue of fact exists as to whether patent in suit, directed to elimination of optical distortion in solar and safety control glass, is invalid for lack of enablement, since patent teaches measurement of texture of solar film layer in glass by calculating "wave index" using average amplitude and average pitch, but amplitude is not defined in patent, since person of ordinary skill in art would recognize several ways to measure amplitude, since amplitude directly impacts wave index calculation, and varying amplitude measurements produces range of wave index results, since novel aspects of invention must not be left to inference, since patent does not specify boundaries for average pitch and amplitude used to calculate wave index, leaving open possibility of range of embodiments that meet limitation but are inoperative, and since patent's rules for determining which wave peaks and valleys are small enough to be eliminated from index calculation are ambiguous.

PATENTS

Particular patents -- General and mechanical -- Safety and solar film for glass

4,973,511, Farmer, Ho, Riek, and Woodard, composite solar/safety film and laminated window assembly made therefrom, summary judgment that patent is not invalid affirmed.

5,091,258, Moran, laminate for a safety glazing, summary judgment that patent is not invalid for lack of enablement reversed.

*1918 Appeal from the U.S. District Court for the Western District of Wisconsin, Shabaz, S.J.

Action by Crown Operations International Ltd. and Marshall H. Krone against Solutia Inc. for declaratory judgment that defendant's patents are invalid. Plaintiffs appeal from grant of summary judgment in favor of defendant. Affirmed as to patent no. 4,973,511; reversed and remanded as to patent no. 5,091,258.

Joseph T. Leone and Joseph A. Ranney, of DeWitt, Ross, and Stevens, Madison, Wis., for plaintiffs-appellants.

Gregory E. Upchurch, Kenneth R. Heineman, and Dudley W. Von Holt, of Thompson Coburn, St. Louis, Mo., for defendant-appellee.

Before Lourie, Clevenger, and Gajarsa, circuit judges.

Gajarsa, J.

Crown Operations International, Ltd., and Mr. Marshall H. Krone (collectively "Crown"), appeal the decision of the United States District Court for the Western District of Wisconsin denying Crown declaratory relief that Solutia's U.S. Patent No. 4,973,511 ("the '511 patent") is invalid for lack of novelty and non-obviousness, and that Solutia's U.S. Patent No. 5,091,258 ("the '258 patent") is invalid for lack of enablement and written description. Crown Operations Int'l, Ltd. v. Solutia, Inc., No. 99-C-802-S, slip op. at 8 (W.D. Wis. Aug. 30, 2000) (memorandum decision and order granting summary judgment) ("August 30 Order"); Crown Operations Int'l, Ltd. v. Solutia, Inc., No. 99-C-802-S, slip op. at 24, 27 (W.D. Wis. Aug. 22, 2000) (same) ("August 22 Order"). Because we find no error in the district court's opinion with respect to the '511 patent, we affirm that portion of the district court's decision. However, because the

district court erred in its analysis of enablement for the '258 patent, and did not address the written description issue for the '258 patent, we reverse the district court's grant of summary judgment on that issue and remand for additional proceedings consistent with this opinion.

I. BACKGROUND

The patents at issue in this appeal relate to layered films used to create safety and solar control glass. An example is an automobile windshield. Most windshields have two layers of glass with a multi-layer film between the glass layers. The multi-layer film adds properties to the glass assembly, such as impact resistance or providing a conductive layer that facilitates defrosting the windshield. An inner layer of the film has solar control properties to selectively reflect, absorb (and thus convert to heat) or transmit defined percentages of certain wavelengths of light. This inner layer is called the solar control film. It is made of a substrate coated by one or more layers of metal or metallic substances. '511 patent, col. 3, l. 64 to col. 4, l. 2. Typically, manufacturers laminate the solar control film between layers of plasticized polyvinyl butyral ("PVB") (sometimes called the "safety film") in a process known as encapsulation. Then, the encapsulated solar control film is sandwiched between two pieces of glass for a final assembly of multi-layer glass with safety and solar control properties.

A. The '511 Patent

The '511 patent is directed to the problem that the metal-coated substrate, i.e., solar control film, tends to wrinkle during encapsulation causing visual distortions. The '511 patent claims to mask the wrinkles from detection by the human eye by limiting to two percent or less the visible light reflection contribution of the solar control film compared to reflection from a complete assembly of glass, PVB and solar control film. '511 patent, col. 4, ll. 46-49, col. 8, l. 66 to col. 9, l. 6, col. 14, l. 67 to col. 15, l. 2. Figure 1 from the '511 patent, set forth below, shows the layers in a complete assembly.

Image 1 (2.5 X 4) Available for Offline Print

The complete safety and solar control glass assembly 10 includes two outer glass layers 28 & 30, PVB layers 22 & 23, and the solar control film 20. The solar control film is comprised of a substrate layer 16 and solar control coating 18. '511 patent, col. 3, ll. 41-53, col. 7, ll. 2-4, col. 10, l. 15. Figure 3 from the

'511 patent, *1919 set forth below, shows the sub-layers of the solar control coating 18.

Image 2 (2 X 3.75) Available for Offline Print

Layer 18 is made of multiple sub-layers. Layers 34 and 36 are metal oxide, and layer 38 is metal. '511 patent, col. 5, ll. 12-14. In addition, the '511 patent notes that "[p]rior automotive windshields have visible light reflection contributions for their solar films of three percent or greater." Further, it relates that the primary method of achieving a low solar control film reflectance contribution is by providing a specially-designed solar coating. '511 patent, col. 4, ll. 56-65.

On December 16, 1999, Crown sued Solutia (the "Initial Complaint"), seeking, among various other relief, a declaration that the '511 patent was invalid for anticipation and obviousness. Upon the parties' cross-motions for summary judgment, the district court found the '511 patent not anticipated and not invalid for obviousness. August 22 Order at 24, 27. We discuss herein only those portions of the August 22 Order relevant to the issues on appeal, which relate solely to the summary judgment finding that the '511 patent was not invalid on the grounds of anticipation and obviousness.

Claim 1, the only independent claim of the '511 patent, is set forth below, with the element numbers from Figure 1 inserted into the claim.

1. A composite solar/safety film [24] for use in a laminated window assembly [10] comprising:

a flexible, transparent plastic substrate layer [16] having a carrier surface and an opposing back surface;

a multilayer solar control coating [18] on said carrier surface, said coated substrate defining a solar control film [20]; and

at least one flexible, transparent, energy absorbing plastic safety layer [23 and/or 22] bonded to a surface of said solar control film;

wherein said solar control film contributes no more than about 2% visible reflectance, based on total visible incident radiation, in a laminated window assembly containing said composite solar/safety film laminated to at least one rigid transparent member [30 and/or 28].

'511 patent, col. 14, l. 57 to col. 15, l. 4 (emphasis added and emphasized numbers added to identify elements shown in Figure 1 above).

Crown argued that U.S. Patent No. 4,017,661 to Gillery (the "Gillery patent") anticipates the '511 patent. The district court held otherwise, because, while the Gillery patent discloses the first three limitations of claim 1 of the '511 patent, it does not disclose the two percent visible reflectance limitation. The court found that neither the Gillery patent claims nor its description expressly disclose a two percent limit on reflectance contribution from the solar control film layer. Crown argued that the two percent limitation was inherently present in the Gillery patent's teachings because the Gillery patent disclosed an assembly with PVB layers, substrate layer, and substrate metal-coating--arguably of the same composition and thickness of the films disclosed by the '511 patent. Thus, Crown argued, because the structure, thickness and materials of the assembly were the same or within the same range(s), the Gillery patent must inherently disclose a two percent limitation. The district court rejected this argument because it found that none of the embodiments disclosed by the Gillery patent meet the two percent visible light reflectance limit. [FN1]

In its August 22 Order, the district court also held that the '511 patent was not rendered invalid for obviousness by Gillery or the other prior art cited by Crown because no prior art discloses: (i) that reflectance below two percent will mask wrinkles; (ii) a solar control film layer with reflectance below two percent; or (iii) any suggestion, motivation or teaching to reduce solar control film visible light reflectivity below two percent. Although the prior art generally sought to reduce visible light reflectivity, it also taught disadvantages of a very thin metal-coating on the substrate, including sacrificing infrared reflectivity. Thus, it taught that the proper compromise to achieve *1920 the conflicting goals of infrared (non-visible light) reflectance, visible light transmission and conductivity was a solar control film with a visible light reflectivity greater than two percent.

B. The '258 Patent

The '258 patent is directed at eliminating optical distortion, called "applesauce," in safety and solar control glass assemblies of the type discussed above for the '511 patent. The '258 patent discloses a method to control distortion otherwise caused by the safety and solar film layer by measuring and controlling the texture of the surface of the PVB layers. The method

expresses texture using a "wave index" and a "roughness value." The wave index calculation is at issue in this appeal. Wave index indicates the relative waviness of the surface of the PVB. Determining wave index involves measuring the surface of the PVB and then aggregating the measurements into a single number, the wave index, through a calculation purportedly described in the '258 patent.

The '258 patent directs one to use an instrument to physically measure the waviness of the surface of the PVB and capture the measurement into an electronic "trace line" representing the contours of the PVB surface. '258 patent, col. 7, ll. 54-65. Since the "trace line" is stored electronically, a computer program is used to calculate wave index from the trace. Three figures from the '258 patent, given below, provide examples of PVB surface trace lines.

Image 3 (3 X 4) Available for Offline Print

The rules for calculating the wave index implement a "smoothing" function. The smoothing process seeks to eliminate minor inflection points (peaks or valleys) to simplify the calculation of wave index. '258 patent, col. 7, l. 66 to col. 8, l. 2.

In the Initial Complaint, Crown sought a declaration that the '258 patent was invalid for anticipation and obviousness. Then, on May 26, 2000, Crown amended the complaint (the "Amended Complaint") to additionally claim in Count VI that the '258 patent is invalid under 35 U.S.C. § 112, first paragraph, because it lacked enablement and written description due to ambiguities in the disclosed wave index calculation. In its August 22 Order, the district court found the '258 patent not anticipated and not invalid for obviousness. August 22 Order at 28-29.

With respect to Count VI of Crown's amended complaint, Solutia moved for summary judgment on Crown's enablement and written description claim. Crown opposed Solutia's summary judgment motion, arguing that the '258 patent did not meet the enablement and written description requirements. The district court found the '258 patent not invalid for lack of enablement, but did not discuss in its opinion the written description requirement. August 30 Order at 8-13. We discuss herein only those portions of the August 30 Order relevant to the issues on appeal, which relate to summary judgment finding the '258 patent not invalid on the grounds of enablement and the procedural disposition of the written description issue.

Claim 1 of the '258 patent is set forth below. In the language of this claim, "laminate" refers to the complete glass, PVB and solar control film assembly, and "functional performance layer" refers to the solar control coating. '258 patent, col. 3, ll. 45-65.

1. A laminate which is substantially free of reflected distortion when used in a safety glazing comprising:

a transparent, thermoplastic substrate layer, optionally surface treated or coated, bearing one or more functional performance layers; and

at least one layer of plasticized polyvinyl butyral bonded on one side to a functional performance layer or the substrate layer and having a roughened deairing surface on its other side characterized by a roughness value, Rz, of at least 10 micrometers;

said at least one plasticized polyvinyl butyral [PVB] layer, before bonding to the substrate layer or functional performance layer, possessing low surface waviness on each side characterized by a wave index *1921 value, WI, of less than 15,000 square micrometers.

'258 patent, col. 12, ll. 2-16 (emphasis added).

Crown argued that the rules disclosed by the '258 patent for calculating wave index are not sufficiently precise to enable a person of ordinary skill in the art to practice the '258 patent without undue experimentation. The wave index calculation as described by the '258 patent is set forth below.

In this regard, considering the waviness profile as a series of peaks and valleys, the smoothing rules of the program consider an inflection point to be a true peak or valley if it is: i) at least 100 micrometers away from the immediately preceding prior peak or valley and ii) at least 0.5 micrometer above or below the immediately preceding prior peak or valley, a valley being at least 0.5 micrometer below the immediately preceding prior peak. Pitch (P) is the distance between one valley and the next valley or in other words across the base of a peak. Average amplitude (H avg) and average pitch (P avg) are determined by the program for the smoothed trace of ten 12.5 mm tracing lengths (the second five lengths being 90° to the first five lengths). From the average of the averaged H's and P's, a WI value is computed from the equation: Wave Index (WI) = (H avg) x (P avg) where H avg and P avg are in microns.

'258 patent, col. 8, ll. 3-19.

Crown asserted that according to the disclosed wave index "calculation," one of ordinary skill in the pertinent art would not know whether to instruct the smoothing program to disregard a peak by comparing it to an immediately preceding peak, or to a valley. The district court held that common sense and the clarifying clause "a valley being at least 0.5 micrometer below the immediately preceding prior peak" defeated Crown's argument. Thus, the district court held that the alleged grammatical ambiguities in the rules disclosed for calculating wave index did not invalidate the patent for lack of enablement.

Crown timely appealed the district court's two orders, raising the issues of anticipation and obviousness of the '511 patent, and lack of enablement and written description of the '258 patent. We have jurisdiction pursuant to 28 U.S.C. § 1295(a)(1).

II. STANDARD OF REVIEW

We review a district court's grant of summary judgment without deference. *Atmel Corp. v. Info. Storage Devices, Inc.*, 198 F.3d 1374, 1378, 53 USPQ2d 1225, 1227 (Fed. Cir. 1999). Summary judgment is appropriate when the moving party demonstrates that "there is no genuine issue as to any material fact and that the moving party is entitled to a judgment as a matter of law." Fed. R. Civ. P. 56(c); *Celotex Corp. v. Catrett*, 477 U.S. 317, 322-23 (1986). On summary judgment, the evidence must be viewed in the light most favorable to the party opposing the motion, *Poller v. Columbia Broad. Sys., Inc.*, 368 U.S. 464, 473 (1962), with doubts resolved in favor of the nonmovant, *Cantor v. Detroit Edison Co.*, 428 U.S. 579, 582 (1976); *Transmatic, Inc. v. Gulton Indus., Inc.*, 53 F.3d 1270, 1274, 35 USPQ2d 1035, 1038 (Fed. Cir. 1995). Once the moving party has satisfied its initial burden, the opposing party must establish a genuine issue of material fact and cannot rest on mere allegations, but must present actual evidence. *Anderson v. Liberty Lobby, Inc.*, 477 U.S. 242, 248 (1986). Issues of fact are genuine only "if the evidence is such that a reasonable jury could return a verdict for the nonmoving party." *Id.* A disputed fact is material if it might affect the outcome of the suit such that a finding of that fact is necessary and relevant to the proceeding. *Id.*; *General Mills, Inc. v. Hunt-Wesson, Inc.*, 103 F.3d 978, 980, 41 USPQ2d 1440, 1442 (Fed. Cir. 1997).

A patent is invalid for anticipation when the same

device or method, having all of the elements contained in the claim limitations, is described in a single prior art reference. *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989); *Perkin-Elmer Corp. v. Computervision Corp.*, 732 F.2d 888, 894, 221 USPQ 669, 673 (Fed. Cir. 1984). An anticipating reference must describe the patented subject matter with sufficient clarity and detail to establish that the subject matter existed in the prior art and that such existence would be recognized by persons of ordinary skill in the field of the invention. See *In re Spada*, 911 F.2d 705, 708, 15 USPQ 1655, 1657 (Fed. Cir. 1990); *Diversitech Corp. v. Century Steps, Inc.*, 850 F.2d 675, 678, 7 USPQ2d 1315, 1317 (Fed. Cir. 1988).

Obviousness is a legal conclusion based on underlying facts of four general types, all of which *1922 must be considered by the trier of fact: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; (3) the differences between the claimed invention and the prior art; and (4) any objective indicia of nonobviousness. See *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 [148 uspq 459] (1966); *Continental Can Co. USA, Inc. v. Monsanto Co.*, 948 F.2d 1264, 1270, 20 USPQ2d 1746, 1750-51 (Fed. Cir. 1991); *Panduit Corp. v. Dennison Mfg. Co.*, 810 F.2d 1561, 1566-68, 1 USPQ2d 1593, 1594 (Fed. Cir. 1987).

"Determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention." *ATD Corp. v. Lydall, Inc.*, 159 F.3d 534, 546, 48 USPQ2d 1321, 1329 (Fed. Cir. 1998). There must be a teaching or suggestion within the prior art, within the nature of the problem to be solved, or within the general knowledge of a person of ordinary skill in the field of the invention, to look to particular sources, to select particular elements, and to combine them as combined by the inventor. See *Ruiz v. A.B. Chance Co.*, 234 F.3d 654, 665, 57 USPQ2d 1161, 1167 (Fed. Cir. 2000); *ATD Corp.*, 159 F.3d at 546, 48 USPQ2d at 1329; *Heidelberger Druckmaschinen AG v. Hantscho Commercial Prods., Inc.*, 21 F.3d 1068, 1072, 30 USPQ2d 1377, 1379 (Fed. Cir. 1994) ("When the patented invention is made by combining known components to achieve a new system, the prior art must provide a suggestion or motivation to make such a combination.").

The written description inquiry is a factual one and must be assessed on a case-by-case basis. See *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, 1561, 19

USPQ2d 1111, 1116 (Fed. Cir. 1991) (quoting *In re Smith*, 458 F.2d 1389, 1395, 173 USPQ 679, 683 (CCPA 1972) ("Precisely how close the original description must come to comply with the description requirement of § 112 must be determined on a case-by-case basis.")). In order to satisfy the written description requirement, the disclosure as originally filed does not have to provide in haec verba support for the claimed subject matter at issue. See *Fujikawa v. Wattanasin*, 93 F.3d 1559, 1570, 39 USPQ2d 1895, 1904 (Fed. Cir. 1996). Nonetheless, the disclosure must convey with reasonable clarity to those skilled in the art that the inventor was in possession of the invention, *Vas-Cath Inc.*, 935 F.2d at 1563-64, 19 USPQ2d at 1116-17, although we have also clarified that the possession test alone is not always sufficient to meet the written description requirement, *Enzo Biochem, Inc. v. Gen-Probe Inc.*, No. 01-1230, 2002 WL 487156, at *7 (Fed. Cir. Apr. 2, 2002). As such, "the written description requirement is satisfied by the patentee's disclosure of 'such descriptive means as words, structures, figures, diagrams, formulas, etc., that fully set forth the claimed invention.'" *Enzo Biochem*, 2002 WL at *7 (quoting *Lockwood v. American Airlines, Inc.*, 107 F.3d 1565, 1572, 41 USPQ2d 1961, 1966 (Fed. Cir. 1997)). Put another way, one skilled in the art, reading the original disclosure, must reasonably discern the limitation at issue in the claims. *Waldemar Link GmbH & Co. v. Osteonics Corp.*, 32 F.3d 556, 558, 31 USPQ2d 1855, 1857 (Fed. Cir. 1994).

Whether a claim is enabled under 35 U.S.C. § 112, first paragraph is a question of law, although based upon underlying factual findings. See *PPG Indus., Inc. v. Guardian Indus. Corp.*, 75 F.3d 1558, 1564, 37 USPQ2d 1618, 1623 (Fed. Cir. 1996); *In re Goodman*, 11 F.3d 1046, 1049-50, 29 USPQ2d 2010, 2013 (Fed. Cir. 1993).

III. DISCUSSION

A. The '511 Patent

On appeal, Crown describes various purported errors in the district court's analysis of the validity of the '511 patent. Despite Crown's contentions, we ascertain no error requiring reversal of the district court's determination of validity over Crown's claims of anticipation and obviousness.

] Regarding alleged anticipation by the Gillery patent, on its face the Gillery patent does not disclose or discuss a two percent limitation for the reflectance contribution of the solar control film. Crown

maintains that the '511 patent merely claims a preexisting property inherent in the structure disclosed in the prior art. Crown urges us to accept the proposition that if a prior art reference discloses the same structure as claimed by a patent, the resulting property, in this case, two percent solar control film reflectance, should be assumed. We decline to adopt this approach because this proposition is not in accordance with our cases on inherency. If the two percent reflectance limitation is inherently disclosed *1923 by the Gillery patent, [FN2] it must be necessarily present and a person of ordinary skill in the art would recognize its presence. In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999); Continental Can, 948 F.2d at 1268, 20 USPQ2d at 1749. Inherency "may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient." Id. at 1269, 20 USPQ2d at 1749 (quoting In re Oelrich, 666 F.2d 578, 581, 212 USPQ 323, 326 (CCPA 1981)).

In arguing inherent disclosure of the two percent limitation in the Gillery patent, Crown bears an evidentiary burden to establish that the limitation was necessarily present. [FN3] The moving party in a summary judgment motion has the burden to show "that there is an absence of evidence to support the non-moving party's case;" the non-moving party must affirmatively demonstrate by specific factual allegations that a genuine issue of material fact exists for trial. Celotex Corp. v. Catrett, 477 U.S. 317, 322-23 (1986). A patent enjoys a presumption of validity, see 35 U.S.C. § 282, which can be overcome only through clear and convincing evidence, see United States Surgical Corp. v. Ethicon, Inc., 103 F.3d 1554, 1563, 41 USPQ2d 1225, 1232 (Fed. Cir. 1997). Given the presumption of validity afforded the '511 patent, Crown has failed to meet its burden because it has not presented sufficient evidence to rebut the facial evidence offered by Solutia that the Gillery patent does not disclose the two percent limitation. See Eli Lilly & Co. v. Barr Lab. Inc., 251 F.3d 955, 962, 58 USPQ2d 1869, 1874 (Fed. Cir. 2001) ("[A] moving party seeking to have a patent held not invalid at summary judgment must show that the nonmoving party, who bears the burden of proof at trial, failed to produce clear and convincing evidence on an essential element of a defense upon which a reasonable jury could invalidate the patent."); In re Robertson, 169 F.3d at 745 (recognizing that extrinsic evidence may be required to establish inherency). Instead, Crown offers only an assumption and its own contentions. [FN4]

Crown also argues that the district court erred by comparing reflectance values in the Gillery patent to non-corresponding values in the '511 patent. August 22 Order at 23-24. While perhaps the district court could have been more careful to explain the basis of its comparison, on a close reading of the district court's analysis we find that the alleged improper comparison only supported the district court's primary point - that no embodiment of the Gillery patent disclosed the two percent limitation, a conclusion that Crown has not shown to be in error.

Finally, Crown argues that various prior art references invalidate the '511 patent as obvious in view of such prior art. Crown's arguments lack merit because it has not shown that the prior art contains a teaching, suggestion or motivation to reduce the reflectance contribution of the solar control film to "no more than about two percent," and the district court properly concluded that there was no such teaching, suggestion or motivation in the prior art cited by Crown. See Ruiz, 234 F.3d at 665, 57 USPQ2d at 1167; In re Rouffet, 149 F.3d 1350, 1359, 47 USPQ2d 1453, 1459 (Fed. Cir. 1998).

B. The '258 Patent

On appeal, Crown argues that the district court erred in analyzing the impact of the ambiguities in the wave index calculation on the enablement requirement for the '258 patent. In addition *1924 to its enablement attack, Crown also argues that the '258 patent does not meet the written description requirement of § 112, first paragraph.

The two requirements, while related and springing from the same factual predicates, [FN5] each carry a separate purpose. The purpose of the enablement requirement is to "ensure[] that the public knowledge is enriched by the patent specification to a degree at least commensurate with the scope of the claims." Nat'l Recovery Techs., Inc. v. Magnetic Separation Sys., 166 F.3d 1190, 1196, 49 USPQ2d 1671, 1675 (Fed. Cir. 1999). One of our predecessor courts has held the enablement and written description requirements to be separate and distinct, and has held that a "specification may contain a disclosure that is sufficient to enable one skilled in the art to make and use the invention and yet fail to comply with the description of the invention requirement." In re Barker and Pehl, 559 F.2d 588, 591, 194 USPQ 470, 472 (CCPA 1977). Subsequently, this court has held that the purpose of the written description is distinct from merely explaining how to

make and use the invention. See *Enzo Biochem*, 2002 WL at *7-8; *Vas-Cath*, 935 F.2d at 1563-64, 19 USPQ2d at 1117. In light of the odd procedural setting of the written description issue in this appeal, our disposition of this appeal based on enablement, and given that the two requirements are distinct and each are necessary, we do not reach the written description issue except to note that it appears to remain available for adjudication or disposition by the district court on remand. [FN6]

Turning to the enablement issue, we agree with Crown that the ambiguities and lack of specified boundary conditions, and Crown's proffered evidence concerning the same, raise a genuine issue of material fact as to whether a person of ordinary skill in the pertinent art could make or use the invention of the '258 patent [FN7] without undue experimentation. *White Consol. Indus. v. Vega Servo-Control*, 713 F.2d 788, 791, 218 USPQ 961, 963-64 (Fed. Cir. 1983). The district court found otherwise. However, it appears not to have considered the statements of Crown's expert concerning the effect of unspecified boundary conditions on the calculation of wave index.

] Following the reasoning of the district court, Solutia argues that a person of ordinary skill in the pertinent art could overcome any ambiguities in the wave index calculation without undue experimentation by testing a limited number of possibilities for computing the wave index. In response, Crown offers statements of its expert that the '258 patent does not define amplitude and that a person of ordinary skill in the art would not know whether to measure amplitude: (i) from a centerline running horizontally through the "middle" of the trace; (ii) from "peak-to-peak," i.e., from the bottom of a valley to the top of a peak; or (iii) from some other baseline or reference running horizontally somewhere through the trace. On its face, the '258 patent does not define amplitude. However, average amplitude directly impacts the wave index calculation because wave index is the result of multiplying average amplitude by average pitch. Simply put, the wave index calculation would produce two separate numbers if *1925 calculated with a centerline versus a "peak-to-peak" amplitude. Worse yet, a range of various wave index values are possible for amplitude baselines running horizontally somewhere through the trace at various locations. To show that the wave index calculation is enabled, Solutia cites various details from the '258 patent concerning how to perform the test to generate a trace of the PVB surface to calculate wave index.

However, Solutia does not present sufficient evidence to rebut Crown's demonstration of the amplitude ambiguity in the wave index calculation. This is so because: (i) the amplitude is a direct input to the critical claim limitation, a wave index of less than 15,000 square micrometers; and (ii) the novel aspects of the invention must be disclosed and not left to inference, that is, a patentee may not rely on the inference of a person of ordinary skill in the pertinent art to supply such novel aspects. See *Genentech Inc. v. Novo Nordisk A/S*, 108 F.3d 1361, 1366, 42 USPQ2d 1001, 1005 (Fed. Cir. 1997) (stating that the knowledge of a hypothetical person of ordinary skill in the art cannot be used to supply the patentable aspects of the invention).

Compounding the amplitude ambiguity, Crown also notes that the wave index is the result of two independently varying, unbounded terms: average pitch and average amplitude. On its face, this does not seem to be a problem. However, Crown's expert noted that because boundary conditions are not specified, the claim covers inoperative embodiments. For example, a wave index of 15,000 square micrometers results from an average height of 1000 micrometers multiplied by an average pitch of 15 micrometers. Yet, according to Crown's expert, an average height of 1000 micrometers would not be acceptable for the PVB. As with the amplitude ambiguity, the problem goes well beyond this single example because a full range of resulting inoperative embodiments are possible for values of average height and average pitch that, when multiplied, produce a wave index value that meets the limitation of the claim. Such inoperative embodiments do not necessarily invalidate the claim. See *Atlas Powder Co. v. E.I. du Pont de Nemours & Co.*, 750 F.2d 1569, 1576-77, 224 USPQ 409, 414 (Fed. Cir. 1984); *In re Cook*, 439 F.2d 730, 735, 169 USPQ 298, 302 (CCPA 1971) (noting that although claims may read on some inoperative embodiments, this does not necessarily invalidate the claim if the necessary information to limit the claims to operative embodiments is known to a person of ordinary skill in the art). [FN8] However, the inoperative embodiments support Crown's assertion that there is a genuine issue of material fact with respect to enablement. See *Atlas Powder*, 750 F.2d at 1576-77; see also *Process Control Corp. v. HydReclaim Corp.*, 190 F.3d 1350, 1358-59, 52 USPQ2d 1029, 1034-35 (Fed. Cir. 1999) (holding that the district court failed in its claim construction to consider the effect of inoperative embodiments on invalidity due to lack of enablement). [FN9]

Further compounding the ambiguities with the wave

index rules, the '258 patent's rules for determining which inflection points are "true" inflection points additionally support Crown's argument that it has raised a genuine issue of material fact. Crown demonstrated in various ways through its experts and arguments the potential indeterminacy in the rules. Solutia's expert admitted that there was some ambiguity in the rules with respect to whether a preceding peak or valley was the reference point in selecting a "true" peak or valley.

Solutia argues that even if the disclosed wave index calculation has ambiguities and is indeterminate, a person of ordinary skill in the pertinent art would be able to make and use the invention with some experimentation, but less than "undue" experimentation. Solutia argues that such a skilled person would only have to try two possibilities for amplitude, centerline and "peak- to-peak," and that experimenting to discover which of two possibilities to use is well within the boundary of undue experimentation. Crown counters that the amplitude ambiguity and potential inoperative embodiments, combined with the ambiguities in the smoothing rules, seems to suggest a *1926 wide range of possibilities which one must try. [FN10] With this wide range of possibilities, we agree that Crown has raised a genuine issue of material fact as to the amount and type of experimentation required, facts that will determine whether such experimentation is undue. See *Enzo Biochem Inc., v. Calgene Inc.*, 188 F.3d 1362, 1371, 52 USPQ2d 1129, 1135-36 (Fed. Cir. 1999) (holding that a reasonable amount of experimentation does not invalidate a patent, but undue experimentation does invalidate, and holding that the Wands factors, which determine whether a patent's disclosure is insufficient such that the experimentation required would be undue, apply to inter partes litigation). [FN11] While ultimately a trier of fact may reach the conclusion that any required experimentation is not undue, Crown has shown that sufficient potential for undue experimentation exists such that disposal on summary judgment is improper.

CONCLUSION

Because we hold that the '511 patent has not been shown to be invalid due to anticipation or obviousness and that a genuine issue of material fact exists with respect to facts underlying the determination of enablement for the '258 patent, we affirm-in-part and reverse-in-part the district court's decision and remand for additional proceedings consistent with this opinion.

AFFIRMED-IN-PART, REVERSED-IN-PART, AND

REMANDED.

COSTS

Each party bears its own costs.

FN1. The district court, applying a similar analysis, also found that UK Patent Application GB 2 057 355 (the "UK patent") did not anticipate the '511 patent because it did not have the two percent limitation.

FN2. In order to claim "equivalent structure" between the Gillery patent and the '511 patent, Crown's inherency argument rests on a precondition of its own making - that the Gillery patent discloses use of TiO_2 , even though it specifies TiO_x , where x is greater than 1.0 but less than 2.0. Although Crown vigorously argues this point, we do not reach this issue because even if Crown is correct that the structures are equivalent, Crown's inherency argument fails for the reasons set forth herein.

FN3. Crown's reliance on *Pall Corp. v. Micron Separations, Inc.*, 66 F.3d 1211, 36 USPQ2d 1225 (Fed. Cir. 1995), and *O.I. Corp. v. Tekmar Co.*, 115 F.3d 1576, 42 USPQ2d 1777 (Fed. Cir. 1997), to characterize the two percent limitation as a "performance limitation" similar to the claim terms at issue in those cases is unpersuasive and overbroad. Respectively, *Pall* and *Tekmar* dealt with the claim terms "skinless" and "passage." Beyond the readily apparent difference between these potentially broad terms and the precise specification of a two percent limit in the '511 patent, characterizing a claim limitation as a "performance characteristic" is not helpful as to whether the "necessarily present" requirement of inherency is met.

FN4. As indicated by this Court's questions at oral argument concerning the seemingly direct route to prove that the Gillery patent contains the two percent limitation--implementing an embodiment of the Gillery patent and testing it--this Court finds puzzling Crown's reluctance regarding this approach to generate extrinsic proof that the Gillery patent inherently meets the two percent limitation.

FN5. Also springing from these same underlying factual predicates is the § 112, second paragraph, definiteness requirement. This requirement is distinct from the enablement and description requirements, which arise from § 112, first paragraph.

[D]efiniteness and enablement are analytically distinct requirements, even though both concepts are contained in 35 U.S.C. § 112. The definiteness requirement of 35 U.S.C. § 112, ¶ 2 is a legal requirement; based on the court's role as construer of

patent claims . . . Definiteness requires the language of the claim to set forth clearly the domain over which the applicant seeks exclusive rights. . . . The test for whether a claim meets the definiteness requirement is "whether one skilled in the art would understand the bounds of the claim when read in light of the specification."

Process Control Corp., 190 F.3d at 1358 n.2, 52 USPQ2d at 1034 n.2 (internal citations omitted). See also 3 Donald S. Chisum, Chisum on Patents, § 8.03 at 8-14(2001) (noting the difference between the requirements of "definiteness, which claims must meet, from the requirements of enablement, which the disclosures of the specification must meet").

FN6. Based on the record before us, the written description issue has the following procedural posture: (i) Crown's Count VI of its amended complaint raised the written description issue; (ii) Solutia's summary judgment motion argued that the '258 patent met the written description requirement; (iii) in opposition Crown argued that the written description requirement was not met; (iv) the district court did not dispose of the written description issue or discuss the issue in its opinion in a way that enables our review; and (v) Crown preserved the written description issue in its appeal to this court and thus has not waived its further adjudication on remand.

FN7. All seventeen claims of the '258 patent refer to wave index, thus they all stand or fall together.

FN8. The court in *In re Cook* further notes that a claim may be invalid if it reads on significant numbers of inoperative embodiments. *In re Cook*, 439 F.2d at 734, 169 USPQ at 301-02 (citing *Graver Tank & Mfg. Co. v. Linde Air Products Co.*, 336 U.S. 271, 276-77, 80 USPQ 451, 453 (1949)). See also *In re Moore*, 439 F.2d 1232, 1236-169 USPQ 236, 239 (CCPA 1971) (noting that the question is whether the scope of enablement conveyed by the disclosure to a person of ordinary skill in the art is commensurate with the scope of protection taught by the claims); Chisum, §

7.03[7][a] at 7-108 & n.6.

FN9. The inoperative embodiment inquiry informs the enablement inquiry; they are not the same inquiry. *Nat'l Recovery Techs.*, 166 F.3d at 1196, 49 USPQ2d at 1676.

FN10. We note that the specification for the '258 patent states that in the disclosed embodiment the wave index is calculated using a software program running on a personal computer being fed the trace line. '258 patent, col. 7, ll. 64-68. Undoubtedly, Solutia took care to ensure that the program contained the necessary boundary conditions and other information to calculate wave index to practice the invention. It appears, however, that Solutia took substantially less care in transcribing the information from the program into the specification's rules for calculating wave index. This incongruity will be relevant to the question of enablement upon remand. See Chisum, § 7.03[4][e] at 7-86 & n.77 ("A specification that claims an invention requiring implementation through computer software but fails to set forth the details of computer programming may present issues of whether the experimentation required to write the programming is reasonable or unreasonable.") (summarizing the teachings of various cases).

FN11. The Wands factors are:

(1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims.

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Appendix 17:

Interconnect Planning Corp. v. Feil, 774 F.2d 1132, 227 U.S.P.Q. 543 (Fed. Cir. 1985).

Interconnect Planning Corporation
v.
Feil, et al.

Court of Appeals, Federal Circuit

Nos. 84-1467 and 85-565

Decided October 9, 1985

United States Patents Quarterly Headnotes

PATENTS

[1] Estoppel -- As to validity -- In general (§ 35.151)

Federal district court decision on patent validity, which was not final, not certified, not appealed, and mooted by subsequent events, does not collaterally estop appeal of those aspects of subsequent decision on reissue of patent which are "common to" earlier decision, since current appeal involves validity of claims of reissue patent, which was issue that did not exist at time of decision on validity of original patent claims.

PATENTS

[2] Patentability -- Anticipation -- In general (§ 51.201)

Reissue -- In general (§ 58.1)

Patent's reissuance with claims that are not substantially identical to original claim requires evaluation of invention as whole, as currently claimed, in terms of 35 USC 103, and original claims, whether valid or invalid, are not prior art against reissued claims.

PATENTS

[3] Patentability -- Aggregation or combination -- In general (§ 51.151)

Federal district court erred by treating each prior art reference as teaching one or more of specific components for use in claimed system, even though such system did not then exist.

PATENTS

Particular patents -- Telephone Switches

Re. 31,144, Feil, Multi-Station Telephone Switching System, holding of invalidity vacated.

*543 Appeal from District Court for the Southern District of New York, Duffy, J.; 223 USPQ 961.

Action by Interconnect Planning Corporation, against

Thomas E. Feil, Robert O. Carpenter, V Brand, Inc., and Turret Equipment Corp., [FNa1] for patent infringement and unfair competition, in which defendants counterclaim *544 for declaration of patent invalidity. From decision granting defendants' motion for summary judgment, plaintiff appeals. Vacated and remanded.

Alfred P. Ewert, and Morgan, Finnegan, Pine, Foley & Lee, both of New York, N.Y. (Jerome G. Lee, Robert A. Molan, and Richard J. McGrath, on the brief, and Howard Karasik, and Sherman & Citron, P.C., both of New York, N.Y., of counsel) for appellant.

Lawrence G. Kurland, and Hubbell, Cohen, Steifel & Gross, P.C., both of New York, N.Y. (Lance J. Lieberman, Daniel L. Dolgin, Towne, Dolgin, Sawyer & Horton, Peter P. Stern, Theodore S. Steingut, and Berger, Steingut, Weiner, Fox & Stern, all of New York, N.Y., on the brief) for appellees.

Before Davis, Smith, and Newman, Circuit Judges.

Newman, Circuit Judge.

Interconnect Planning Corporation (IPC) appeals from the summary judgment of the United States District Court for the Southern District of New York, *Interconnect Planning Corp. v. Feil*, 587 F.Supp. 1495, 223 USPQ 961 (S.D.N.Y. 1984), holding invalid all the claims of IPC's Reissue Patent No. 31,144 entitled "Multi Station Telephone Switching System," invention of Thomas E. Feil, for failure to meet the conditions for patent validity under 35 U.S.C. § 103, and dismissing IPC's count for patent infringement. We hold that invalidity under § 103 has not been proven, as a matter of law. We vacate the summary judgment of invalidity and dismissal of the infringement count, and remand to the district court.

Background

The claims of Reissue Patent No. 31,144 are for certain telephone systems known as "trader turrets", which are multi-line telephone consoles used by the financial community in trading networks for securities, commodities, currency, and the like. The purpose of these systems is to facilitate concurrent telephone connections for traders requiring multiple sources of price information, conducting multiple transactions, and generally meeting the communication demands of

busy, often hectic, financial trading enterprises. Trading rooms may house a hundred or more trader turrets.

Because of the large number of lines and connections required and the specific needs of these communication networks, these systems are complex. A high degree of reliability is required in their operation, because even momentary failures can be extremely costly.

The record shows that the Feil trader turrets rapidly achieved commercial success, displacing other systems then in use. IPC attributes the success of the Feil invention to its novel system "architecture", which enabled ease of operation, high capacity, and improved reliability over the systems then available. IPC's sales of the Feil trader turrets, according to the record, grew from \$320,000 for 20 units in 1974, its first year, to \$27,900,000 for 3500 units in 1983.

Thomas Feil, the inventor, was formerly an officer and part owner of IPC. In 1977 Mr. Feil formed the defendant company V Band Systems, Inc., and in 1980 Mr. Feil left IPC and joined V Band, of which he is president and chief executive officer. Defendants make and sell the trader turrets that are here accused of patent infringement.

On November 21, 1980, IPC filed suit in the Southern District of New York asserting infringement of U.S. Patent No. 3,991,282 (the '282 patent), invention of Thomas Feil. Defendants Feil and V Band raised the defense this patent was invalid in terms of 35 U.S.C. § 103. IPC's count for unfair competition was dismissed by the court and is not before us. Various counterclaims were separated and are apparently still pending.

In May of 1981 IPC filed in the U.S. Patent and Trademark Office (the PTO) an application to reissue the '282 patent. IPC cited to the examiner articles by M.E. Ozenberger and W.H. Keith, both of the Bell Telephone Laboratories, on which articles defendants were relying before the district court, and which had not previously been before the examiner. The district court refused to stay the action before it pending completion of the reissue examination, and therefore the reissue examination was suspended by the PTO in accordance with its rules. On defendants' motion for summary judgment, the district court on June 1, 1982 held all claims of the '282 patent invalid for obviousness under 35 U.S.C. § 103. *Interconnect Planning Corp. v. Feil*, 543 F.Supp. 610, 614-19, 215

USPQ 734, 736-41 (S.D.N.Y. 1982).

Following this decision, at IPC's request the PTO resumed examination of the reissue application. The court's decision was provided to and considered by the examiner. A supplemental *545 reissue declaration by IPC referred to this decision as a basis for the reissue application. The '282 patent was surrendered, and on February 8, 1983 the PTO granted the reissue patent, RE 31,144, IPC having restricted its claims in various ways and having overcome the newly cited prior art.

Defendants moved for summary judgment of invalidity of the reissue patent, asserting collateral estoppel based on the court's decision on the '282 patent, and also asserting invalidity under 35 U.S.C. § 103. IPC resisted the motion, and the parties' memoranda, affidavits, depositions, and other documents are of record. For reasons similar to those of the 1982 decision, the motion for summary judgment was granted on June 20, 1984.

That decision, holding all of the reissue claims invalid, was certified and made final under Fed. R. Civ. P. 54(b), with instructions by the court that IPC "attempt to have any appeal . . . heard at the same time and before the same panel" as any appeal from a decision on the same patent by the United States District Court for the District of New Jersey. [FN1] We agreed. Both appeals are decided this day.

Although both appeals involved similar issues and argument, specific to the New York suit are certain procedural issues, as discussed infra.

Collateral Estoppel

Defendants argue that IPC's appeal rights are curtailed on the basis of collateral estoppel. Two separate but related issues of estoppel are raised, both arising out of the district court's 1982 decision on the '282 patent.

A.

Defendants assert first that IPC can not now appeal from or argue those aspects of the 1984 decision on the reissue patent which are "common to" the 1982 decision on the '282 patent, on the ground that those aspects could have been appealed earlier, and that it is too late to do so now. IPC asserts in response that (1) the issues are not the same, (2) a different patent is involved, and (3) the 1982 decision was not final.

Considering the finality issue, for collateral estoppel to arise the prior decision need not have been final in the sense of 28 U.S.C. §1291 but, in the words of the Restatement, the prior adjudication must have been "sufficiently firm to be accorded conclusive effect". Restatement (Second) of Judgments § 13 (1982). Sufficient firmness, according to the Restatement, requires that the party against whom the estoppel is asserted have had the right, even if not exercised, to challenge on appeal the correctness of the earlier decision. Restatement (Second) of Judgment, § 13 reporter's note comment f (1982). Defendants argue that IPC had three such opportunities: appeal under 28 U.S.C. § 1292(a)(1), which governs appeals from interlocutory orders involving injunctions; appeal under 28 U.S.C. § 1292(c)(2), which governs appeals in patent infringement cases final except for an accounting; and appeal under Fed.R.Civ.P. 54(b), which governs judgment on fewer than all of multiple claims in an action.

None of these situations controls the case before us. 28 U.S.C. § 1292(a)(1) relates to orders involving injunctions, and although defendants argue that IPC's complaint necessarily invokes this section, this does not impart automatic appealability to interlocutory orders that do not involve injunctions. As for 28 U.S.C. § 1292(c)(2), the district court's judgment was not final except for an accounting, in light of the pendency of counterclaims. 9 J. Moore, B. Ward, & J. Lucas, Moore's Federal Practice, P 110.19[4], at 220 (1985). Fed. R. Civ. Proc. 54(b) requires that the court have expressly directed entry of a final judgment; and that "[i]n the absence of such determination and direction, any [decision] which adjudicates fewer than all the claims . . . shall not terminate the action as to any of the claims". See also 6 Moore's Federal Practice P 54.42, at 813.

Neither IPC nor the defendants asked the district court to enter a final judgment on its decision holding the '282 patent invalid, and the court did not do so. Defendants assert, however, that IPC should now be estopped because it did not move for finality of the ruling nor request that the judgment be certified for interlocutory appeal. An application for certification is by no means certain to be granted and, in this case, IPC's eventual request for certification of the original decision was opposed by defendants and was refused by the court.

The law of collateral estoppel is not intended to penalize a party for declining to try to take a piecemeal appeal. Further, the '282 patent had been placed in

reissue, and an appeal on the merits of patent claims for which reissue was being sought would have been a meaningless exercise, as may have been recognized at the time.

[1] We conclude that the district court's 1982 decision on the '282 patent claims, a *546 decision not final, not certified, not appealed, and mooted by subsequent events, lacks collateral estoppel effect for the purpose urged by defendants. The issue here on appeal is the validity of the claims of the reissue patent, an issue that did not exist at the time of the decision on validity of the '282 patent claims. There is no estoppel against appellate review of all aspects pertinent to the decision on the reissue claims. 1B Moore's Federal Practice P 0.441 [3.-3], at 737.

B.

IPC asserts that the district court incorrectly invoked collateral estoppel when it analyzed the reissue claims by comparing them with the original claims of the '282 patent, then applying prior art only to the differences between the reissue claims and the original claims. Our predecessor court, the U.S. Court of Claims, [FN2] has confronted related situations, wherein estoppel was raised as to unadjudicated claims of a patent whose other claims had been adjudicated in an earlier action. The Court of Claims adopted a pragmatic approach, stating that the first step was to determine whether any new issues were raised as to the nonlitigated claims. In *Westwood Chemical, Inc. v. United States*, 525 F.2d 1367, 1375, 187 USPQ 656 (Ct.Cl. 1975), adopting 186 USPQ 383, 389 (Ct.Cl.Tr.Div. 1975), the court said:

Where obviousness is the basis for the prior invalidity holding, an inquiry into the identity of the validity issue is more properly phrased in terms of the factual inquiries mandated by *Graham v. John Deere Co.*, 383 U.S. 1, 17, 148 USPQ 459, 466-467, 86 S.Ct. 684, 15 L.Ed.2d 545 (1966), as a prerequisite to such a validity determination.

Applying the *Graham* guidelines, the court said:

Thus, the inquiry should be whether the nonlitigated claims present new issues as to the art pertinent to the nonlitigated claims; as to the scope and content of that art; as to the differences between the prior art and the nonlitigated claims; and as to the level of ordinary skill in that art. If none of these inquiries raises any new triable issues, then the obviousness determination in the

prior proceeding should be equally applicable to the nonlitigated claims.

Id. See also *Bourns, Inc. v. United States*, 537 F.2d 486, 199 USPQ 256 (Ct. Cl. 1976), adopting 187 USPQ 174 (Ct. Cl. Tr. Div. 1975); *Carter- Wallace, Inc. v. United States*, 496 F.2d 535, 538, 182 USPQ 172, 175 (Ct. Cl. 1974) (in determining the applicability of the estoppel, the first consideration is "whether the issue of invalidity common to each action is substantially identical.").

The question of substantial identity of reissue claims arose in *Plastic Container Corp. v. Continental Plastics of Oklahoma, Inc.*, 607 F.2d 885, 203 USPQ 27 (10th Cir. 1979), cert. denied, 444 U.S. 1018, 204 USPQ 696 (1980), wherein the court determined that the reissue claims were not substantially identical to the original claims, and therefore that collateral estoppel did not apply.

In *Bourns*, responding to plaintiff's argument that according collateral estoppel effect to non-identical adjudicated claims would amount to treating the claims previously held to be invalid as prior art, the court agreed that this would be inappropriate:

A domino approach in which each successively narrower claim is compared with the one before it, not with the prior art, is inappropriate since it improperly gives prior-art effect to the subject matter of an invalid claim. In *re Craig and Street*, Cust. & Pat. App., 411 F.2d 1333, 1335, 162 USPQ 157, 158-159 (1969).

537 F.2d at 493, 187 USPQ at 179.

The district court compared the reissue claims with the '282 claims, and erroneously concluded that reissue claims 1 through 6 were substantially identical to the original claims, and that reissue claims 7 through 9, although not substantially identical, involved some substantially identical "issues".

This erroneous legal conclusion may have compounded the error in the next step, wherein the court compared the differences between the original and the reissue claims with prior art that was pertinent only to those differences, thus effectively giving the original claims prior art effect -- the pitfall against which *Bourns* cautioned:

A claim may be invalid for obviousness under 35 U.S.C. § 103 but still describe a combination not

found in the prior art. Moreover, it is well settled that each claim of a patent is entitled to a presumption of validity and is to be treated as a complete and independent invention. 35 U.S.C. § § 282, 288. *Leeds & Catlin v. Victor Talking Machine Co.*, 213 U.S. 301, 319, 29 S.Ct. 495, 53 L.Ed. 805 (1909); *Smith Industries International v. Hughes Tool Co.*, 396 F.2d 735, 736 (5th Cir. 1968).

[2] *547 Id. When a patent has been reissued with claims that are not substantially identical to the original claims, the invention as a whole, as now claimed, must be evaluated in terms of 35 U.S.C. § 103. The original claims, whether valid or invalid, are not prior art against the reissued claims.

The Summary Judgment

The proceeding from which this appeal is taken was styled "summary", in that the court's decision was made on defendants' motion for summary judgment. The earlier decision on the '282 patent was also made on defendants' motion for summary judgment. IPC contends that the matter was inappropriate to summary judgment, in view of the presence of disputed issues of material fact.

Defendants Feil and V Band argued before the district court, and repeat before us, that no material fact is in dispute, that the questions before the district court and before us in this appeal are purely legal ones, and that the issue was properly dealt with summarily. In its discussion of reissue claims 7 through 9, which claims had no counterpart in the original patent, the district court referred to "claims and issues that have not yet been subjected to a full and fair adjudication", 587 F.Supp. at 1500, 223 USPQ at 965; the court viewed both proceedings as "full" as well as fair, a process not always accommodated by summary proceedings on a documentary record.

Obviousness vel non under 35 U.S.C. § 103 is a question of law, whose conclusion requires preliminary determination of several underlying factual issues, as set out in *Graham v. John Deere Co.*, 338 U.S. 1, 148 USPQ 459 (1966). See also *Gardner v. TEC Systems, Inc.* 725 F.2d 1338, 1344-45, 220 USPQ 777, 782-83 (Fed. Cir.) (in banc), cert. denied, 105 S.Ct. 116, 225 USPQ 232 (1984). These factual issues relate to the scope and content of the prior art, the differences between the prior art and the claimed invention as a whole, the level of ordinary skill in the art at the time the invention was made, and the so-called "secondary

considerations" that reflect the contemporaneous response to the invention.

In reviewing IPC's assertions that there were genuine issues of material fact relating to the Graham inquiries, we have reviewed the submissions of the parties. Before the court, according to the record, were all the references cited as prior art; as well as the depositions of Examiner Randall P. Myers of the United States Patent and Trademark Office, engineer John Fitzmaurice of New York Telephone, and inventor/defendant Thomas E. Feil; and various documentary exhibits. Also of record were the affidavits of Alan R. Fitzpatrick, president of American Telecommunications Concepts; IPC's technical experts Dennis Maywald and Herbert Goldwag; Thomas P. Bradbury, vice president and treasurer of IPC; and extensive written submissions and arguments.

Although fact and opinion are intertwined in many of these documents, the factual considerations required by the Graham analysis appear to have been adequately presented in the record. The technological structure and operation of the devices of the prior art were not in material dispute, [FN3] although there was strong dispute about the relationship of the teachings of the references to the problems solved by the Feil system, and the weight to be given to evidence of the Feil invention's commercial success.

The district court stated that expert testimony was unnecessary, *Interconnect Planning Corp. v. Feil*, 587 F.Supp. at 1497, 223 USPQ at 963, and held all of the reissue claims invalid. As will be discussed, we think that the district court reached this conclusion by incorrectly applying the law of 35 U.S.C. § 103.

35 U.S.C. § 103

Those charged with determining compliance with 35 U.S.C. § 103 are required to place themselves in the minds of those of ordinary skill in the relevant art at the time the invention was made, to determine whether that which is now plainly at hand would have been obvious at such earlier time.

The invention must be viewed not with the blueprint drawn by the inventor, but in the state of the art that existed at the time.

The invention must be evaluated not through the eyes of the inventor, who may have been of exceptional skill, but as by one of "ordinary skill." See *Stewart-Warner Corp. v. City of Pontiac, Michigan*, 767 F.2d

1563, *548 1570, 226 USPQ 676, 680-81 (Fed. Cir. 1985).

This is not a facile statutory interpretation. The quality of non-obviousness is not easy to measure, particularly when challenged years after the invention was made. That which may be made clear and thus "obvious" to a court, with the invention fully diagrammed and aided, in this case, by a hostile inventor seeking to eliminate his own invention, may have been a breakthrough of substantial dimension when first unveiled.

The judicial application of uniform standards for determining compliance with 35 U.S.C. § 103 is essential, because the technological incentives fostered by the patent system depend on consistent interpretation of the law. To this end, faithful adherence to the patent statute and guiding precedent fosters uniformity in result.

A.

Following examination by the Patent and Trademark Office, a duly issued patent is presumed valid, as is a duly reissued patent. The burden of proving otherwise resides with the person challenging its validity. 35 U.S.C. §282.

This statutory presumption derives in part from recognition of the technological expertise of the patent examiners. A reissue application receives a fresh examination, normally concentrated on those references and reasons that occasioned its filing. The record shows that this reissue application received a supplemental internal review by three examiners because it was involved in litigation.

Although IPC's view is incorrect that the PTO's decision must be given controlling weight, we do agree that the examination procedure and result should be given appropriate consideration and due weight by the court. As stated in *Fromson v. Advance Offset Plate, Inc.*, 755 F.2d 1549, 1555, 225 USPQ 26, 31 (Fed. Cir. 1985), "[t]he Examiner's decision, on an original or reissue application, is never binding on the court. It is, however, evidence the court must consider in determining whether the party asserting invalidity has met its statutory burden by clear and convincing evidence".

Upon reissue the "burden of proving invalidity was made heavier", as stated in *Fromson*, supra. This burden must be met by the party asserting invalidity.

The district court here relied on the identical references that had been before the reissue examiners, and disdaining the need for expert testimony, reached a different conclusion in law. Although we affirm the obligation of the district court to reach an independent conclusion, the reissue patent reaches the court clothed in a statutory presumption of validity, and clear and convincing evidence is required to surmount this presumption. *American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, 725 F.2d 1350, 1359-60, 220 USPQ 763, 770 (Fed. Cir.), cert. denied, 105 S.Ct. 95, 224 USPQ 520 (1984).

B.

The court referred to the content of the prior art references in broad terms, occasionally using the title of a reference to explain its pertinence. In this crowded art of telephone systems, as IPC correctly pointed out, it is not enough to show that each of the components used by Feil was known, and had been used in other telephone systems. Feil did not claim to have invented any of the components of his claimed system.

[3] From its discussion of the prior art it appears to us that the court, guided by the defendants, treated each reference as teaching one or more of the specific components for use in the Feil system, although the Feil system did not then exist. Thus the court reconstructed the Feil system, using the blueprint of the Feil claims. As is well established, this is legal error. *Kalman v. Kimberly-Clark Corp.*, 713 F.2d 760, 774, 218 USPQ 781, 791 (Fed. Cir. 1983), cert. denied, 104 S.Ct. 1284, 224 USPQ 520 (1984).

Illustrative is the court's analysis of reissue claim 1. Pertinent is not only its analysis of the differences between the reissue claim and the prior art, but also the differences between the reissue claim and the original claim. In claim 1, matter enclosed in brackets appeared in the original claim but forms no part of the reissue claim, and matter printed in italics was added by reissue:

1. For a telephone system in which telephone communication is capable of being established for each telephone station of a plurality of telephone stations over a standard telephone line by directly connecting each telephone station to a selected standard telephone line of a plurality of standard telephone lines, each of said plurality of standard telephone lines capable of being directly connected to each of said plurality of telephone stations, an

improvement comprising:

a plurality of pairs of contacts, with respective pairs of said contacts being connected with respective ones of said standard telephone lines for allowing said communication;

a plurality of relay coils, with respective ones of said relay coils controlling respective pairs of said contacts to be opened or closed;

*549 a plurality of sets of non-locking pushbutton [switch means] switches with each set of pushbutton [switch means] switches connected to respective ones of said telephone stations with respective ones of said pushbutton [switch means] switches of said sets of pushbutton [switch means] switches corresponding to respective ones of said standard telephone lines and being connected with respective ones of said relay coils and being depressed for energizing a selected one of said relay coils for closing a corresponding pair of contacts to allow said telephone communication; [and]

an electronic holding circuit for each of said relay coils, said holding circuits being operative

to establish a held state after initial energization of the associated relay coil by momentarily depressing the associated pushbutton switch, and

to maintain said corresponding pair of contacts closed while in the held state;

a logic circuit for each station connected to said holding circuits to detect conditions for releasing the held state;

each of said stations comprising [first light display means] a set of status lights, connection means connecting corresponding pushbuttons of said sets of pushbutton [switch means] switches in each of said stations and to said [first light display means] status lights for energizing said [first light display means] status lights in each station to display the status of each of said plurality of standard telephone lines in each of said stations,

said station further comprising [first light display means] an active line indicator separate from said status lights connected to said pushbutton [switch means] switches for identifying the standard telephone line of said plurality of standard telephone lines that the telephone station is using for said

telephone communication.

Reissue claim 1 was held invalid on two grounds. The first ground was that it was substantially identical to claim 1 of the '282 patent, and thus invalid on the basis of collateral estoppel. The court in its 1982 decision referred to Carter U.S. Patent No. 3,150,238 and Foulkes U.S. Patent No. 3,757,056 as disclosing "non-locking buttons, relay coils and pairs of contacts" as applied to the original claim 1. In the 1984 decision the court stated that "Claim 1 has not been changed in such a way that alters the above finding of disclosure by prior art." 587 F.Supp. at 1499, 223 USPQ at 964. This treatment of the reissue claim is not supported by the claim content, as will be apparent from the court's further discussion of claim 1.

As the second ground for its holding of invalidity the court analyzed the changes made by reissue. The court identified three areas as new to reissue claim 1, and applied five references to these areas as follows: "See Defendants' Exhs. C13, D4-D6 (non-locking buttons); Defendants' Exhs. C4, C7 (holding circuits); Defendants' Exhs. C16, C13 (separate active lines)." Id. at 1499, 223 USPQ at 964 (footnotes omitted).

The first set of cited exhibits refers to articles by Keith, "A New Switching System for Right of Way Companies," Bell Laboratories Record, Apr. 1968, and Ozenberger, "Voice Communication System for Air Traffic Control," Bell Laboratories Record, May 1961, which the court stated taught the use of non-locking pushbuttons. The second set refers to the Carter patent, which the district court said teaches a "Relay Control Circuit" (the title of the Carter patent), and the Foulkes patent which "recites that [e]ach of these [control] circuits may take any desired and presently known form . . . to perform a recognized control function . . . evaluat[ing] the 'hold' feature". Id. at 1499 n.6, 223 USPQ at 946 n.6. The third set of exhibits refers to Simon U.S. Patent No. 3,928,732, which the district court described by its title, "Extension and Line Indicating Display System for Key Telephone System," and Keith, which the district court stated "also discloses separate active lines." Id. at 1499 n.7, 223 USPQ at 964 n.7.

The court's analysis of the scope of the new material in reissue claim 1 in itself shows the error in the court's conclusion that as a matter of law reissue claim 1 is substantially identical to its parent claim. The claim limitations of the electronic holding circuits for each relay coil, the logic circuit, and separate active line indicator, in combination with the non-locking

pushbutton switches connected to the relay coils, were added by reissue. Observing these differences, their relationship to the invention as a whole, and the prior art, we conclude as a matter of law that reissue claim 1 is not substantially identical to the original claim. The 1982 decision, which was directed to the original claims, does not apply to the reissue claims. Collateral estoppel as a basis for the court's holding of invalidity is not supported in law.

Having determined that a reissue claim is not substantially identical to the parent, the parent claim is of no further moment. As stated in *Wayne-Gossard Corp. v. Moretz Hosiery Mills, Inc.*, 539 F.2d 986, 991, 191 USPQ 543, 546-47 (4th Cir. 1976), "the original claim was at an end, denuded of all potency save as a bench mark of interpretation, at the time of the reissue's infringement."

***550** The original claim is not prior art against the reissue claim. It is not correct to weigh the reissue claim against the original claim. It is not correct to weigh the changes in the reissue claim against the original claim. It is the reissue claim alone that is to be analyzed in accordance with the Graham guidelines, and the differences to be considered are the differences between the reissue claim as a whole and the prior art.

In the court's 1982 analysis of the original claims, to which the court referred in its 1984 decision, the court had identified "six principal features which plaintiff argues are not obvious" and explained why the court concluded that these features are obvious by referring to various prior art references showing various of the features in various contexts. *Interconnect Planning Corp. v. Feil*, 543 F.Supp. at 617, 215 USPQ at 739. As we have observed, it is the emphasis on the obviousness of "features," rather than the claimed telephone system as a whole, that constitutes the flaw in the application of section 103 to the Feil claims. As stated in *In re Shuman*, 361 F.2d 1008, 1012, 150 USPQ 54, 57 (CCPA 1966):

It is impermissible to first ascertain factually what appellants did and then view the prior art in such a manner as to select from the random facts of that art only those which may be modified and then utilized to reconstruct appellants' invention from such prior art.

The court in 1982 summarized its conclusion with respect to these six "features" by observing (1) that although the pairs of contacts and relay coils "is not disclosed in either the Keith Article or the Ozenberger

Article", the Foulkes and Carter patents do disclose them; (2) that Keith, Ozenberger, and Foulkes refer to pushbutton switches; (3) that Keith shows a set of display lamps although Ozenberger uses a single lamp, and that Paraskevatos (U.S. Patent No. 3,727,003) and Simon et al. show either a digital display or the incoming line number; (4) that Paraskevatos shows a decoder and that "the diode matrix was no mystery to one engineer" (Thomas Fitzmaurice, of Bell Labs, who testified that he readily understood the Feil system after he was shown it); (5) that Keith shows which lines are active; and (6) that the asserted unique master station hook up with blocking means is shown in Ozenberger and a Verdon patent (U.S. Patent No. 3,819,871). *Interconnect Planning Corp. v. Feil*, 543 F.Supp. at 617-19, 215 USPQ at 739-40.

In its 1984 decision the court added the additional citations of references pertinent to the changes in the reissue claims, as discussed above. As in its citation of references against the various features of the original claims, the court selected from each reference a feature or features that also appeared in the reissue claims. No reference, however, suggested the overall arrangement, the "architecture", of the Feil system.

IPC presented affidavit testimony explaining the references in the context of the state of the telephone systems art at the time, none of which testimony was controverted other than by attorney argument. The most advanced multi-line devices at the time the invention was made, according to this record, used the then state-of-the-art crossbar switching equipment, and electrical or mechanical interconnections or interlocks. The two Bell Labs publications of Keith and Ozenberger, on which defendants and the district court placed substantial emphasis, used crossbar switching. Feil did not.

Mr. Feil's affidavit filed with the district court states "The Ozenberger and Keith articles disclose what I thought I invented in 1974". Mr. Feil made no reference to the crossbar switches required by these references, and offered no discussion of either differences or similarities between his system and those of these references.

The Carter patent used relay switches in the telephone switching system it describes. Carter, of Bell Laboratories, taught the use of quick-release control relays in combination with slow-release work relays, to achieve the specific purposes desired by Carter. Carter also required use of a "locking chain" rather than independently operating relays, and a more complex

communication path as compared with Feil's direct connections. Feil established multiple direct connections in a system where theretofore it was believed, according to the record, that crossbar switches would be required.

The Feil system eliminated both crossbar switches and mechanical interlocks or mechanically locking pushbuttons, and instead used relays, a well-known type of switch. But Feil avoided the need (of Carter) to establish potentially large numbers of contacts and operates a concomitantly large number of relays in series in order to connect stations within the system. As IPC's uncontroverted testimony shows, Feil avoided interconnections and interlocks, both of which, according to the Maywald affidavit, had previously been considered necessary to lock out faults. The Maywald affidavit stated that Carter's approach would be "impossible and impractical" in the trader turret application because "[t]o try and accurately control the release times of different relays over a long period of time would be virtually impossible considering the wear and deterioration of components" in a "trader turret network involving some 20,000 or more relays". Maywald's explanation of the *551 technical operation of the references is uncontradicted, although defendants take issue in attorney argument with Maywald's conclusions.

The Foulkes patent, on which the district court also relies, described a "bipolar multiplexing circuit" based on a "contact tree" relay switching arrangement. Foulkes taught a telephone system that Maywald avers, without contradiction, "could not be realistically expanded into large systems like trader turrets". The district court did not explain how the Foulkes or other systems of different circuitry made obvious the different system of Feil's claims.

The Keith and Ozenberger systems, as previously discussed, are different systems from that of Feil. Like the systems of the other references, they contain some elements in common with that of Feil. The Ozenberger system, based on crossbar switches, was designed for air traffic control. The Keith system is described as tailored to the specific needs of "right-of-way" companies, and is a cordless system limited to up to eight consoles of up to a hundred lines. As Keith says, "[a] system of crossbar switches is the heart of the switching system". Neither Keith nor Ozenberger suggests that the crossbars be replaced with relays and that the other changes be made to produce the admittedly different Feil system.

The novelty of the Feil system is not controverted by the defendants. Its value in trader turret systems has received the ultimate recognition, market success and imitation.

35 U.S.C. § 103 requires that obviousness be determined with respect to the invention as a whole. See, e.g., *Jones v. Hardy*, 727 F.2d 1524, 1528, 220 USPQ 1021, 1024 (Fed. Cir. 1984); *W.L. Gore & Assocs, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1548, 220 USPQ 303, 309 (Fed. Cir. 1983), cert. denied, 105 S.Ct. 172 (1984); *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1537, 218 USPQ 871, 877 (Fed. Cir. 1983). This is essential for combination inventions, for generally all combinations are of known elements. *Environmental Designs, Ltd. v. Union Oil Co. of California*, 713 F.2d 693, 698, 218 USPQ 865, 870 (Fed. Cir. 1983), cert. denied, 104 S.Ct. 709, 224 USPQ 520 (1984).

When prior art references require selective combination by the court to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gleaned from the invention itself. *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577 & n.14, 221 USPQ 929, 933 & n.14 (Fed. Cir. 1984). There must be "something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination". *Lindemann Maschinenfabrik GmbH v. American Hoist and Derrick Co.*, 730 F.2d 1452, 1462, 221 USPQ 481, 488 (Fed. Cir. 1984).

Critical to the analysis is an understanding of the particular results achieved by the new combination. The claims here at issue are directed to a combination of known components of telephone systems in an admittedly new way to achieve a new total system. Neither the district court in its opinion, nor he defendants, identified any suggestion in the prior art that the components be combined as they were by Feil or that such combination could achieve the advantages of the Feil system.

Not only must the claimed invention as a whole be evaluated, but so also must the references as a whole, so that their teachings are applied in the context of their significance to a technician at the time -- a technician without our knowledge of the solution. The defendants propounded and the district court appears to have followed an analytical method that well illustrates the "mosaic" analogy discussed in *W.L. Gore & Assocs.*, 721 F.2d at 1552, 220 USPQ at 3312, where this court said:

[T]he claims were used as a frame, and individual naked parts of separate prior art references were employed as a mosaic to recreate a facsimile of the claimed invention.

Defendants refer to the decision of the Supreme Court in *Sakraida v. Ag Pro, Inc.*, 425 U.S. 273, 189 USPQ 449 (1976). As the Court there held, Sakraida's combination of old elements to wash barn floors with flowing water did not produce a new or different function, and affirmed the district court's holding that "all of the elements of [the combination] are old . . . and the combination of them . . . being neither new nor meeting the test of non-obviousness." *Id.* at 274, 189 USPQ at 450. In the Feil invention the combination was admittedly new, and it produced a new system having theretofore unavailable attributes.

Recognizing the difficulty of casting one's mind back to the state of technology at the time the invention was made, courts have long recognized the usefulness of evidence of the contemporaneous attitude toward the asserted invention. A retrospective view of the invention is best gleaned from those who were there at the time. Mr. Feil, the inventory impugning his own invention, now avers that he did no more than did the prior art, specifically the Keith and Ozenberger articles. Mr. Feil's disavowal of his invention is staunch, although he less modestly commented in 1977, before he left IPC, on the reaction of Bell Labs' engineer at that earlier time:

He [Fitzmaurice] showed too much enthusiasm. I mean, he was really excited by the *552 thing. Like this is incredible. You guys are geniuses.

You're 50 miles ahead of Bell Labs. (App. Vol. VI, F357).

You know what he said. He said You're 50 miles ahead of Bell Lab? He said "miles", not years, he made it in miles. You're 50' miles ahead of the Bell Labs. (App. Vol. VI, F355).

Mr. Elia of the Republic Bank, one of IPC's customers, attested:

Upon viewing the equipment, the AT&T people indicated that it was unbelievable. They did not think it could be done. They were surprised that it was done. (App. Vol. VI, F360).

Although the district court remarked in its 1982

decision that evidence of commercial success "cannot be afforded any weight" "in light of my finding of obviousness", 543 F.2d at 619, 215 USPQ at 741; such evidence when present must be considered and afforded appropriate weight. *Simmons Fastener Corp. v. Illinois Tool Works, Inc.*, 739 F.2d 1573, 1575, 222 USPQ 744, 746 (Fed. Cir. 1984), cert. denied, 105 S.Ct. 2138 (1985); *Jones v. Hardy*, 727 F.2d at 1530, 220 USPQ at 1026; *Medtronic, Inc. v. Cardiac Pacemakers, Inc.*, 721 F.2d 1563, 1575, 220 USPQ 97, 105 (Fed. Cir. 1983); *Stratoflex, Inc.*, 713 F.2d at 1538-39, 218 USPQ at 879; *In re Sernaker*, 702 F.2d 989, 996, 217 USPQ 1, 7 (Fed. Cir. 1983); *In re Mageli*, 470 F.2d 1380, 1383, 176 USPQ 305, 307 (CCPA 1973). IPC offered affidavit and deposition evidence, by two experts in telephone systems and by a Bell system engineer knowledgeable in the field of trader turrets. Their uncontroverted testimony was to the effect that the Feil system was perceived at the time as an exceptional technological achievement.

The requirement that "secondary considerations" be considered in determinations under section 103 aids in evaluating the state of the art at the time the invention was made. *In re Piasecki*, 745 F.2d 1468, 1475, 223 USPQ 785, 790 (Fed. Cir. 1984). It is not pertinent that the invention was easily understood after it was made -- a factor that appears to have been considered significant by the district court, see 543 F.Supp. at 619, 215 USPQ at 741 -- but whether it would have been obvious to make the invention at the time. Giving due weight to the market success and contemporaneous reaction to the Feil trader turret system, the record does not contain clear and convincing evidence that the Feil invention of the reissue claims would have been obvious to one of ordinary skill in this art at the time the invention was made.

Reissue claims 2-9 are either dependent on reissue claim 1, include similar limitations, or include additional limitations. Although each claim has been considered separately, they need not here be treated in redundant detail. For each claim we are compelled to

the conclusion that the burden of proving invalidity by clear and convincing evidence has not been met.

The summary judgment of invalidity of Reissue Patent No. 31,144, in terms of 35 U.S.C. § 103, is vacated, as is the dismissal of the infringement claim. The case is remanded to the district court for further proceedings consistent herewith.

VACATED and REMANDED.

FN1 The complaint against Robert O. Carpenter and Turret Equipment Corp. was dismissed by stipulation, and they are not parties to this appeal.

FN1 *IPC Communications, Ltd. v. Standard Teleservices Supply, Inc.*, No. 81-1832D (D.N.J. 1984) (unreported), vacated and remanded, No. 84-1599 (Fed. Cir. -----, 1985) (unreported).

FN2 *In South Corp. v. United States*, 690 F.2d 1368, 215 USPQ 657 (Fed. Cir. 1982), the Federal Circuit adopted as precedent the decisions of the Court of Claims and the Court of Customs and Patent Appeals.

FN3 IPC argues that the district court should not have resolved any question of substantial identity between the claims of the original and reissue patents in defendants' favor because that is a contested fact question which should not have been resolved against the nonmovant, citing *Tee-Pak, Inc. v. St. Regis Paper Co.*, 491 F.2d 1193, 1200, 181 USPQ 75, 80 (6th Cir. 1974). Under this court's precedent substantial identity between claims, a matter of claim interpretation, is a question of law. See, e.g., *Raytheon Co. v. Roper Corp.*, 724 F.2d 951, 956, 220 USPQ 592, 596 (Fed. Cir. 1983), cert. denied, 105 S.Ct. 127, 225 USPQ 232 (1984).

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227 U.S.P.Q. 543

END OF DOCUMENT

Appendix 18:

W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 220 U.S.P.Q. 303
(Fed. Cir. 1983).

W.L. Gore & Associates, Inc.

v.

Garlock, Inc.

Court of Appeals, Federal Circuit

Nos. 83-613/614

Decided Nov. 14, 1983

United States Patents Quarterly Headnotes

PATENTS

[1] Court of Appeals for the Federal Circuit -- Weight given decision reviewed (§ 26.59)

Parties' argument relating to salutary injunction of FRCivP 52(a) cannot be controlling on all issues, where dispositive legal error occurred in interpretation and application of patent statute, 35 USC.

PATENTS

[2] Court of Appeals for the Federal Circuit -- Weight given decision reviewed (§ 26.59)

Findings that rest on erroneous view of law may be set aside on that basis.

PATENTS

[3] Construction of specification and claims -- Claim defines invention (§ 22.30)

Claims measure and define invention.

PATENTS

[4] Construction of specification and claims -- Combination claims (§ 22.35)

Infringement -- Process patents (§ 39.65)

Court's restriction of claimed multi-step process to one step constitutes error, whether done at behest of patentee relying on that restriction to establish infringement by one who employs only that one step in process otherwise distinct, or at behest of accused infringer relying on that restriction to establish invalidity by showing that one step in prior art process otherwise distinct; invention must be considered as whole.

PATENTS

[5] Court of Appeals for the Federal Circuit -- Weight given decision reviewed (§ 26.59)

CAFC is not at liberty to substitute its own for district court's findings underlying district court's conclusion that claim is invalid.

PATENTS

[6] Patentability -- Anticipation -- Process (§ 51.225)

It is irrelevant that those using invention may not have appreciated results where patent owner's operation of device is consistent, reproducible use of claimed invention; were that alone enough to prevent anticipation, it would be possible to obtain patent for old and unchanged process.

PATENTS

[7] Use and sale -- Extent and character of use (§ 69.5)

Nonsecret use of claimed process in usual course of producing articles for commercial purposes is public use.

PATENTS

[8] Use and sale -- Extent and character of use (§ 69.5)

Patentees' commercialization of product produced by its patented process can result in forfeiture of patent granted them for that process on application filed by them more than one year later; however, third party secret commercialization of process cannot be bar to patent grant on that process.

PATENTS

[9] Patent grant -- Intent of patent laws (§ 50.15)

Early public disclosure is linchpin of patent system.

PATENTS

[10] Interference -- Priority (§ 41.70)

Law disfavors prior inventor who benefits from process by selling its product but suppresses, conceals, or otherwise keeps process from public, as against later inventor who promptly files patent application from which public will gain disclosure of process.

PATENTS

[11] Patentability -- Evidence of -- In general (§ 51.451)

District court that in its consideration of prior art disregarded unpredictability and unique nature of product to which claimed inventions relate errs.

PATENTS

[12] Construction of specification and claims -- By prior art (§ 22.20)

District court that in its consideration of prior art considers claims in less than their entireties errs.

PATENTS

[13] Patentability -- Evidence of -- Suggestions of prior art (§ 51.469)

District court that considers references in less than their entireties, i.e., in disregarding disclosures in references that diverge from and teach away from invention at hand, errs.

PATENTS

[14] Construction of specification and claims -- Comparison with other claims (§ 22.40)

Claims must be considered individually and separately.

PATENTS

[15] Patentability -- Anticipation -- Combining references (§ 51.205)

There must have been something present in teachings in references to suggest to one skilled in art that claimed invention before court would have been obvious.

PATENTS

[16] Patentability -- Evidence of -- Suggestions of prior art (§ 51.469)

Fact that patentee proceeded contrary to accepted wisdom of prior art is strong evidence of nonobviousness.

PATENTS

[17] Patentability -- Tests of -- Skill of art (§ 51.707)

Imbuing one of ordinary skill in art with knowledge of invention in suit, when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to insidious effect of hindsight syndrome wherein that which only inventor taught is used against its teacher.

PATENTS

[18] Patentability -- Invention -- In general (§ 51.501)
Patentability -- Tests of -- Skill of art (§ 51.707)

Decisionmaker must forget what he or she has been taught at trial about claimed invention and cast mind back to time invention was made to occupy mind of one skilled in art who is presented only with references, and who is normally guided by then-accepted wisdom in art.

PATENTS

[19] Pleading and practice in courts -- Burden of proof -- Validity (§ 53.138)

Presumption for patent grant -- Patent Office consideration of prior art (§ 55.5)

It is not law that presumption of validity is weakened greatly where Patent Office has failed to consider pertinent prior art; presumption has no separate evidentiary value; it cautions decisionmaker against

rush to conclude invalidity; submission of additional art that is merely "pertinent" does not dispel that caution; however, inescapable burden of persuasion on one who would prove invalidity remains throughout trial.

PATENTS

[20] Pleading and practice in courts -- Burden of proof -- Validity (§ 53.138)

Presumption from patent grant -- Patent Office consideration of prior art (§ 55.5)

Burden of proving invalidity may be facilitated by prior art that is more pertinent than that considered by PTO.

PATENTS

[21] Patentability -- Evidence of -- In general (§ 51.451)

District court that specifically declines to consider objective evidence of nonobviousness errs; that evidence can often serve as insurance against insidious attraction of siren hindsight when confronted with difficult task of evaluating prior art; even when prior art evidence points more in direction of nonobviousness than obviousness, objective evidence may tend to reassure decisionmaker.

PATENTS

[22] Patentability -- Anticipation -- In general (§ 51.201)

Anticipation requires disclosure in single prior art reference of each element of claim under consideration.

PATENTS

[23] Patentability -- Anticipation -- Process (§ 51.225)
Patentability -- Composition of matter (§ 51.30)

Anticipation of inventions set forth in product claims cannot be predicated on mere conjecture respecting characteristics of products that might result from practice of processes disclosed in references.

PATENTS

[24] Patentability -- Anticipation -- Infringement as test (§ 51.211)

Accused infringer's employment of process of dominating patent is not anticipation of invention described and claimed in improvement patent.

PATENTS

[25] Patentability -- Anticipation -- In general (§ 51.201)

Patentability -- Invention -- In general (§ 51.501)

Inherency and obviousness are distinct concepts.

PATENTS

[26] Patentability -- Evidence of -- In general (§ 51.451)

All evidence bearing on obviousness issue, as with any other issue raised in conduct of judicial process, must be considered and evaluated before required legal conclusion is reached.

PATENTS

[27] Patentability -- Evidence of -- In general (§ 51.451)

Objective evidence of nonobviousness, i.e., "indicia" of *Graham v. John Deere Co.*, 148 USPQ 459, may in given case be entitled to more weight or less, depending on its nature and its relationship to invention's merits; it may be most pertinent, probative, and revealing evidence available to aid in reaching conclusion on obvious/nonobvious issue.

PATENTS

[28] Patentability -- Evidence of -- Commercial success -- In general (§ 51.4551)

Praise greeting products claimed in patent from suppliers, including owner of prior art patent, is objective evidence of nonobviousness.

PATENTS

[29] Patentability -- Composition of matter (§ 51.30)

Claim to new product is not required to include critical limitations.

PATENTS

[30] Specification -- Sufficiency of disclosure (§ 62.7)

Patents are written to enable those skilled in art to practice invention, not public, and Section 112 speaks as of application filing date, not as of time of trial.

PATENTS

[31] Specification -- Sufficiency of disclosure (§ 62.7)

Section 112 requires that inventor set forth best mode of practicing invention known to him at time application was filed.

PATENTS

[32] Claims -- Indefinite -- In general (§ 20.551)

Use of "stretching at rate exceeding specific percent per second" in claims is not indefinite.

PATENTS

[33] Claims -- Specification must support (§ 20.85)

It is claimed invention for which enablement is required.

PATENTS

[34] Specification -- Sufficiency of disclosure (§ 62.7)

Patent is not invalid merely because some experimentation is needed; patent is invalid only when those skilled in art are required to engage in undue experimentation to practice invention.

PATENTS

[35] Construction of specification and claims -- Claim defines invention (§ 22.30)

Distinguishing what infringes from what does not is role of claims, not of specification.

PATENTS

[36] Construction of specification and claims -- Defining terms (§ 22.45)

Patent applicant can be his own lexicographer.

PATENTS

[37] Defenses -- Fraud (§ 30.05)

Fraud must be shown by clear and convincing evidence; state of mind of one making representations is most important of elements to be considered in determining existence of fraud; good faith and subjective intent, while they are to be considered, should not necessarily be made controlling; under ordinary circumstances, fact of misrepresentation coupled with proof that party making it had knowledge of its falsity is enough to warrant drawing inference that there was fraudulent intent; where public policy demands complete and accurate disclosure it may suffice to show nothing more than that misrepresentations were made in atmosphere of gross negligence as to their truth.

PATENTS

[38] Pleading and practice in courts -- Issues determined -- Validity and infringement (§ 53.505)

Better practice is for district court to decide both validity and infringement issues when both are contested at trial, enabling conduct of single appeal and disposition of entire case in single appellate opinion.

PATENTS

[39] Infringement -- Tests of -- Comparison with claim (§ 39.803)

Infringement is decided with respect to each asserted claim as separate entity.

PATENTS

Particular patents -- Porous Products

3,953,566, *Gore*, Process for Producing Porous Products, holding of invalidity of claims 3 and 19 reversed and of claims 1 and 17 affirmed.

4,187,390, Gore, Porous Products and Process Therefor, holding of invalidity reversed.

*306 Appeal from District Court for the Northern District of Ohio, Manos, J.; 220 USPQ 220.

Consolidated actions by W. L. Gore & Associates, Inc., against Garlock, Inc., for patent infringement, in which defendant counterclaims for declaratory judgment of patent invalidity, noninfringement, fraudulent solicitation, and entitlement to attorney fees. From judgment for defendant, plaintiff appeals and defendant cross-appeals. Affirmed in part, reversed in part, and remanded; Davis, Circuit Judge, concurring in result in part and dissenting in part, with opinion.

David H. Pfeffer, New York, N.Y. (J. Robert Dailey and Janet Dore, both of New York, N.Y., and John S. Campbell, Newark, Del., of counsel) for appellant.

John J. Mackiewicz, Philadelphia, Pa. (Dale M. Heist, Philadelphia, Pa., on the brief, Bernard Ouziel, New York, N.Y., of counsel) for appellee.

Before Markey, Chief Judge, and Davis and Miller, Circuit Judges.

Markey, Chief Judge.

Appeal from a judgment of the District Court for the Northern District of Ohio holding U.S. Patents 3,953,566 ('566) and 4,187,390 ('390) invalid. We affirm in part, reverse in part, and remand for a determination of the infringement issue.

Background

Tape of unsintered polytetrafluorethylene (PTFE) (known by the trademark TEFLON of E.I. du Pont de Nemours, Inc.) had been stretched in small increments. W. L. Gore & Associates, Inc. (Gore), assignee of the patents in suit, experienced a tape breakage problem in the operation of its "401" tape stretching machine. Dr. Robert Gore, Vice President of Gore, developed the invention disclosed and claimed in the '566 and '390 patents in the course of his effort to solve that problem. The 401 machine was disclosed and claimed in Gore's U.S. Patent 3,664,915 ('915) and was the invention of Wilbert L. Gore, Dr. Gore's father. PTFE tape had been sold as thread seal tape, i.e., tape used to keep pipe joints from leaking. The '915 patent, the application for which was filed on October 3, 1969, makes no reference to stretch rate, at 10% per second or otherwise, or to matrix tensile strength in excess of

7,300 psi.

Dr. Gore experimented with heating and stretching of highly crystalline PTFE rods. Despite slow, careful stretching, the rods broke when stretched a relatively small amount. Conventional wisdom in the art taught that breakage could be avoided only by slowing the stretch rate or by decreasing the crystallinity. In late October 1969, Dr. Gore discovered, contrary to that teaching, that stretching the rods as fast as possible enabled him to stretch them to more than ten times their original length with no breakage. Further, though the rod was thus greatly lengthened, its diameter remained virtually unchanged throughout its length. The rapid stretching also transformed the hard, shiny rods into rods of a soft, flexible material.

Gore developed several PTFE products by rapidly stretching highly crystalline PTFE, including: (1) porous film for filters and laminates; (2) fabric laminates of PTFE film bonded to fabric to produce a remarkable material having the contradictory properties of impermeability to liquid water and permeability to water vapor, the material being used to make "breathable" rainwear and filters; (3) porous yarn for weaving and braiding into other products, like space suits and pump packing; (4) tubes used as replacements for human arteries and veins; and (5) insulation for high performance electric cables.

*307 On May 21, 1970, Gore filed the patent application that resulted in the patents in suit. The '566 patent has 24 claims directed to processes for stretching highly crystalline, unsintered, PTFE. The processes, inter alia, include the steps of stretching PTFE at a rate above 10% per second and at a temperature between about 35 degreesC and the crystalline melt point of PTFE. The '390 patent has 77 claims directed to various products obtained by processes of the '566 patent.

It is effectively undisputed that the present inventions filled a long sought yet unfilled need. The United States Army and the research director of a Garlock Inc. (Garlock) customer had been looking for and following up every remote lead to a waterproof/breathable material for many years.

It is undisputed that the present inventions enjoyed prompt and remarkable commercial success due to their merits and not to advertising or other extraneous causes.

It is undisputed that the inventions provide the most

important synthetic material available for use in vascular surgery, hundreds of thousands of persons having received artificial arteries formed of the patented products since 1976, and that the patented products have unique properties useful in other medical procedures, in communications satellites, radar systems, and electrical applications.

It is undisputed that the major sources of PTFE, ICI and du Pont, greeted the patented products as "magical," "bewitching," "a remarkable new material," and one that "differs from other processed forms of Teflon."

It is undisputed that the patented products were met with skepticism and disbelief by at least one scientist who had worked with PTFE at du Pont for many years and who testified as an expert at trial.

It is undisputed that Garlock first produced an accused product in response to a customer's request for a substitute for the patented product, that Garlock

advertised its accused product as a "new form" of PTFE and as "a versatile new material which provides new orders of performance for consumer, industrial, medical and electrical applications," and that the customer describes that accused product as "a new dimension in rainproof/breathable fabrics."

Proceedings

On Nov. 2, 1979, Gore sued Garlock for infringement of process claims 3 and 19 of the '566 patent, and sought injunctive relief, damages and attorney fees. Garlock counterclaimed on Dec. 18, 1979, for a declaratory judgment of patent invalidity, non-infringement, fraudulent solicitation, and entitlement to attorney fees. On Feb. 7, 1980, Gore filed a second suit for infringement of product claims 14, 18, 36, 43, 67 and 77 of the '390 patent. In light of a stipulation, the district court consolidated the two suits for trial.

Gore alleged infringement of certain claims by certain products:

'566 patent claims	'390 patent claims	Garlock Product
19	14, 43	film
--	36, 77	laminate
19	18	yarn
--	67	braided packing
3	--	tape

At trial, Garlock addressed only claims 1, 3, 17, and 19 of the '566 patent and claims 1, 9, 12, 14, 18, 35, 36, 43, 67 and 77 of the '390 patent. See Appendix to this opinion.

The district court, in a thorough memorandum accompanying its judgment, and in respect of the '566 patent: (1) found claim 1 anticipated under 35 U.S.C. § 102(a) by Gore's use of its 401 machine and use by the Budd Company (Budd) of a Cropper machine; (2) declared all claims of the patent invalid under 102(b) because the invention had been in public use and on sale more than one year before Gore's patent application, as evidenced by Budd's use of the Cropper machine; (3) held claims 1, 3, 17 and 19 invalid for obviousness under 35 U.S.C. § 103, on the basis of various reference pairings: (a) Japanese patent 13560/67 (Sumitomo) with U.S. patent 3,214,503 (Markwood); (b) U.S. patent 2,776,465 (Smith) with Markwood; or (c) Gore's '915 patent with Sumitomo;

and (4) held all claims invalid as indefinite under 35 U.S.C. § 112. [FN1]

***308** In its opinion respecting the '390 patent, the district court held: (1) claims 1, 9, 12, 14, 18, 35, 36, 43, 67 and 77 invalid §§102 and 103 in view of Sumitomo and Smith; and (2) all claims invalid as indefinite under § 112.

The court found that Gore did not commit fraud before the Patent and Trademark Office (PTO), denied Garlock's request for attorney fees, and refrained from deciding the infringement issue.

Issues

Did the district court err in: (1) its holding of invalidity under §§102(a), 102(b), 103 and 112; (2) its finding that Gore did not commit fraud on the PTO; or (3) denying attorney fees.

Opinion

This hard fought and bitterly contested case involved over two years of discovery, five weeks of trial, the testimony of 35 witnesses (19 live, 16 by deposition), and over 300 exhibits. The district court issued an exhaustive 37- page memorandum opinion reflective of a careful, conscientious approach to the determination of the many issues presented at trial.

The record on appeal consists of 2000 pages. The parties' briefs total 199 pages. In those briefs, counsel repeatedly accuse each other of numerous and serious breaches of the duty of candor owed the court. Each cites instances in which the testimony, the findings, and the record are or are said to be quoted in part and out of context. As a result, the usefulness and reliability of the briefs as means of informing the court has been greatly diminished if not destroyed, and careful, time-consuming study of all exhibits and each page of the record has been required.

Appellant cited 80 prior court opinions in its main brief. Appellee's brief totally ignores all but two of those citations, but adds 57 more. Appellant's reply brief cites 126 prior court opinions, 34 earlier cited, 67 newly cited, and 25 of those cited by appellee. Appellee's reply brief cites 17 prior court opinions, 4 earlier cited, 7 newly cited, and 6 of the 147 cited by appellant. Accordingly, 211 prior court opinions have been evaluated in relation to the proof found in the record.

In light of the entire record and the applicable law, we are convinced that Garlock failed to carry its burden of proving all claims of the present patents invalid.

Standard of Review

[1][2] Where, as here, dispositive legal error occurred in interpretation and application of the patent statute, 35 U.S.C., the parties' arguments relating to the salutary injunction of Fed.RuleCiv.P. 52(a) cannot be controlling on all issues. Findings that "rest on an erroneous view of the law may be set aside on that basis," Pullman-Standard v. Swint, 456 U.S. 273 (1982). Thus it is unnecessary here to set aside any probative fact found by the district court on the basis of its being clearly erroneous, or to engage in what would be an inappropriate reweighing of the facts.

Among the legal errors extant in the record, each of which is discussed below, are (1) the invention set forth in each claim was not in each instance considered

as a whole; (2) 35 U.S.C. §102(b) was applied though criteria for its application were not present; (3) the references were not assessed in their entireties; (4) an inherency theory under §§102 and 103 was inappropriately applied; (5) that which only the inventor taught was attributed to the prior art; (6) individual steps in prior art processes dealing with materials distinct from those with which the present inventions dealt were erroneously equated to steps in the claimed processes; (7) objective evidence of nonobviousness was disregarded; and (8) the function and application of §112 were misconstrued.

Because it permeated so much of the district court's analysis, we note more fully its frequent restriction of its consideration to 10% per second rate of stretching, which it called the "thrust of the invention." That approach is repeated throughout Garlock's briefs, which refer repeatedly to the "thrust of the invention," to "the inventive concept," and to the claims "shorn of their extraneous limitations." That facile focusing on the "thrust," "concept," and "shorn" claims, resulted in treating the claims at many points as though they read differently from those actually allowed and in suit.

[3] *309 It is true that Dr. Gore emphasized rapid stretching, for example, as well as the amount of stretch and other process limitations, during prosecution of the application for the '566 patent. Yet it is the claims that measure and define the invention. Aro Manufacturing Co. v. Convertible Top Replacement Co., 365 U.S. 336, 339, 128 USPQ 354 (1961); Bowser, Inc. v. U.S., 388 F.2d 346, 349, 156 USPQ 406, 409 (Ct. Cl. 1967).

[4] Each claimed invention must be considered as a whole. 35 U.S.C. § 103; Schenck, A.G. v. Nortron Corp., 218 USPQ 698, 700 (Fed. Cir. 1983). In determining obviousness, there is "no legally recognizable or protected 'essential,' 'gist,' or 'heart' of the invention." Aro, 365 U.S. at 345. A court's restriction of a claimed multi-step process to one step constitutes error, whether done at the behest of a patentee relying on that restriction to establish infringement by one who employs only that one step in a process otherwise distinct, or at the behest of an accused infringer relying on that restriction to establish invalidity by showing that one step in a prior art process otherwise distinct.

(1) Invalidity

(a) '566 Patent

(i) §102(a) and The 401 Machine

It is undisputed that the district court held only claim 1 of the '566 patent to have been anticipated under § 102(a) by operation of the 401 machine in the Gore shop before Dr. Gore's invention in late October 1969. It did so on the deposition testimony of two former Gore employees, documents, and drawings of the 401 machine.

In August 1969, Gore offered to sell to Export Tool Company (Export) tape "to be made" on the 401 machine. Tape made on the 401 machine was shipped to Export on October 24, 1969. The trial judge found the rolls on the 401 machine were, at least at some point in time before October 1969, spaced less than four feet apart and that the rate of stretch accomplished in operating that machine (admittedly operated in accord with the description of machine operation in the '915 patent) must have been greater than 10% per second. The district court credited testimony that Teflon 6-c, a highly crystalline form of Teflon, was used because it was the standard resin at the time, and that the tape was stretched at a temperature above 35 degreesC. Thus it cannot be said that the record fails to support the district court's finding that the limitations of claim 1 were met by Gore's operation of the 401 machine before Dr. Gore's asserted "late October 1969" date of invention. Though he was working with the operation of the 401 machine, Dr. Gore offered no proof that his invention date was before the date of shipment to Export.

[5] Gore, seeking a review here of the evidence, points to certain inadequacies as indicating a failure to meet the required clear and convincing standard under §102(a). At the time of trial, the district court, bound by precedent then applicable, applied a preponderance of the evidence test. Gord asserts, erroneously, that the clearly erroneous standard does not therefore apply on this appeal. Gore does not, however, point to any basis on which the district court's findings must be held to have been clearly erroneous under the clear and convincing standard. We are not at liberty, of course, to substitute our own for the district court's findings underlying its conclusion that claim 1 is invalid.

[6] Gore's operation of the 401 machine must thus be viewed as a consistent, reproducible use of Dr. Gore's invention as set forth in claim 1, and it is therefore irrelevant that those using the invention may not have appreciated the results. General Electric Co. v. Jewel Incandescent Lamp Co., 326

U.S. 242, 248, 67 USPQ 155, 157-58 (1945). Were that alone enough to prevent anticipation, it would be possible to obtain a patent for an old and unchanged process. Ansonia Brass & Copper Co. v. Electric Supply Co., 144 U.S. 11, 18 (1892); see, H.K. Regar & Sons, Inc. v. Scott & Williams, Inc., 63 F.2d 229, 231, 17 USPQ 81, 83 (2d Cir. 1933).

[7] The nonsecret use of a claimed process in the usual course of producing articles for commercial purposes is a public use. Electric Storage Battery Co. v. Shimadzu, 307 U.S. 5, 20, 41 USPQ 155, 161 (1939), and there was no evidence that any different process was used to produce the articles shipped to Export.

Thus it cannot be said that the district court erred in determining that the invention set forth in claim 1 of '566 patent was known or used by others under §102(a), as evidenced by Gore's operation of the 401 machine before Dr. Gore's asserted date of that invention.

In view of our affirmance of the judgment reached on claim 1 under 102(a), we need not discuss other asserted grounds of invalidity of claim 1. There was, however, no evidence whatever that the inventions set forth in other claims, of either the '566 or the '390 patent, were known or used by others as a result of Gore's operation of the 401 machine before late October 1969.

*310 (ii) §102(b) and the Cropper Machine

In 1966 John W. Cropper (Cropper) of New Zealand developed and constructed a machine for producing stretched and unstretched PTFE thread seal tape. In 1967, Cropper sent a letter to a company in Massachusetts, offering to sell his machine, describing its operation, and enclosing a photo. Nothing came of that letter. There is no evidence and no finding that the present inventions thereby became known or used in this country.

In 1968, Cropper sold his machine to Budd, which at some point thereafter used it to produce and sell PTFE thread seal tape. The sales agreement between Cropper and Budd provided:

ARTICLE "E" - PROTECTION OF TRADE
SECRETS Etc:

1. BUDD agrees that while this agreement is in force it will not reproduce any copies of the said apparatus without the express written permission of Cropper nor will it divulge to any person or

persons other than its own employees or employees of its affiliated corporations any of the said known-how or any details whatsoever relating to the apparatus.

2. BUDD agrees to take all proper steps to ensure that its employees observe the terms of Article "E" 1 and further agrees that whenever it is proper to do so it will take legal action in a Court of competent jurisdiction to enforce any one or more of the legal or equitable remedies available to a trade secret plaintiff.

Budd told its employees the Cropper machine was confidential and required them to sign confidentiality agreements. Budd otherwise treated the Cropper machine like its other manufacturing equipment.

A former Budd employee said Budd made no effort to keep the secret. That Budd did not keep the machine hidden from employees legally bound to keep their knowledge confidential does not evidence a failure to maintain the secret. Similarly, that du Pont employees were shown the machine to see if they could help increase its speed does not itself establish a breach of the secrecy agreement. There is no evidence of when that viewing occurred. There is no evidence that a viewer of the machine could thereby learn anything of which process, among all possible processes, the machine is being used to practice. As Cropper testified, looking at the machine in operation does not reveal whether it is stretching, and if so, at what speed. Nor does looking disclose whether the crystallinity and temperature elements of the invention set forth in the claims are involved. There is no evidence that Budd's secret use of the Cropper machine made knowledge of the claimed process accessible to the public.

The district court held all claims of the '566 patent invalid under 102(b), *supra*, note 3, because "the invention" was "in public use [and] on sale" by Budd more than one year before Gore's application for patent. Beyond a failure to consider each of the claims independently, 35 U.S.C. §282; *Altoona Publix Theatres, Inc. v. American Tri-Ergon Corp.*, 294 U.S. 477, 487, 24 USPQ 308 (1935), and a failure of proof that the claimed inventions as a whole were practiced by Budd before the critical May 21, 1969 date, it was error to hold that Budd's activity with the Cropper machine, as above indicated, was a "public" use of the processes claimed in the '566 patent, that activity having been secret, not public.

Assuming, *arguendo*, that Budd sold tape produced

on the Cropper machine before October 1969, and that that tape was made by a process set forth in a claim of the '566 patent, the issue under §102(b) is whether that sale would defeat Dr. Gore's right to a patent on the process inventions set forth in the claims.

[8] If Budd offered and sold anything, it was only tape, not whatever process was used in producing it. Neither party contends, and there was no evidence, that the public could learn the claimed process by examining the tape. If Budd and Cropper commercialized the tape, that could result in a forfeiture of a patent granted them for their process on an application filed by them more than a year later. *D.L. Auld Co. v. Chroma Graphics Corp.*, No. 83-585, slip op. at 5-6 (Fed. Cir. Aug. 15, 1983); See *Metalizing Engineering Co. v. Kenyon Bearing & Auto Parts Co.*, 153 F.2d 516, 68 USPQ 54 (2d Cir. 1946). There is no reason or statutory basis, however, on which Budd's and Cropper's secret commercialization of a process, if established, could be held a bar to the grant of a patent to Gore on that process.

[9][10] Early public disclosure is a linchpin of the patent system. As between a prior inventor who benefits from a process by selling its product but suppresses, conceals, or otherwise keeps the process from the public, and a later inventor who promptly files a patent application from which the public will gain a disclosure of the process, the law favors the latter. See *Horwath v. Lee*, 564 F.2d 948, 195 USPQ 701 (CCPA 1977). The district court therefore erred as a matter of law in applying the statute and in its determination that Budd's secret use of the Cropper machine and sale of tape rendered all process *311 claims of the '566 patent invalid under §102(b).

(iii) §103

In considering claims 1, 3, 17, and 19 of the '566 patent, the district court recognized that analysis of the obviousness issue under §103 requires determination of the scope and content of the prior art, the differences between the prior art, and the claims at issue, and the level of ordinary skill in the pertinent art. *Graham v. John Deere Co.*, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966).

[11][12][13] In its consideration of the prior art, however, the district court erred in not taking into account the import of the markedly different behavior of PTFE from that of conventional thermoplastic polymers clearly established and

undisputed on the record, and in thus disregarding the unpredictability and unique nature of the unsintered PTFE to which the claimed inventions relate, *In re Whiton*, 420 F.2d 1082, 164 USPQ 455 (CCPA 1970); in considering claims in less than their entireties, *Schenck*, supra; and in considering the references in less than their entireties, i.e., in disregarding disclosures in the references that diverge from and teach away from the invention at hand. *In re Kuderna*, 426 F.2d 385, 165 USPQ 575 (CCPA 1970).

Invalidity of claim 1 under §102(a) having been determined, it is unnecessary to discuss in detail the applicability of §103 to that claim. If claim 1 had not been held anticipated under §102(a) in light of operation of the 401 machine, it is clear from the discussion here that claim 1 could not properly have been held invalid under §103.

Claim 3 depends from and thus incorporates claim 1 but specifies a rate of stretch of 100% per second. Claim 17 also depends from claim 1 and specifies an amount of stretch of about twice the original length. Claim 19 depends from claim 17 but specifies an amount of stretch of about five times the original length.

U.S. patent 2,983,961 to Titterton, Volume 13 of the *Encyclopedia of Polymer Science and Technology* (1970), the Sumitomo patent, and witnesses for both parties, establish that teachings related to conventional thermoplastic polymers are inapplicable to PTFE.

Articles by Dogliotti and Yelland, *Effect of Strain Rate on the Viscoelastic Properties of High Polymeric Fibrous Materials*, 4 *High Speed Testing* 211 (1964) and Robinson and Graham, *Methods of Characterization of Polymeric Materials by High Speed Testing Techniques*, 5 *High Speed Testing* 261 (1965), teach that conventional plastics and sintered PTFE can be stretched further if stretched slowly. Dr. Gore demonstrated at trial and at oral argument before us that an attempt to stretch highly crystalline, unsintered PTFE slowly results in breakage, and that rapid stretching produces a greatly lengthened rod of soft, flexible material.

The '566 patent contains an example of stretching an article to 16 times its length. Smith and the '915 patent teach that PTFE could not be stretched beyond four times its length without heating it to above its crystalline melt temperature, a step avoided by Dr. Gore and as set forth in the claims.

Sumitomo teaches that there is a length limit to stretching unsintered PTFE, and does not suggest what that limit might be. Markwood, U.S. patent 3,208,100 to Nash (Nash), and U.S. patent 2,823,421 to Scarlett (Scarlett) teach that non-PTFE thermoplastics can be stretched rapidly and to extended lengths, and also teach reduction, elimination, or avoidance of crystallinity before stretching.

The disclosure in the Smith and '915 patents that a PTFE article may be stretched to as much as four times its length encompasses the step of stretching to twice its length set forth in claim 17 and establishes that such step would have been obvious.

[14] Claims 3 and 19 must be considered individually and separately. 35 U.S.C. §282. Nowhere, in any of the references, is it taught or suggested that highly crystalline, unsintered PTFE could be stretched at a rate of about 100 per second as required by asserted claim 3. Nor is it anywhere suggested that by rapid stretching a PTFE article be stretched to more than five times its original length as required by asserted claim 19. On the contrary, the art as a whole teaches the other way.

[15] In concluding that obviousness was established by the teachings in various pairs of references, the district court lost sight of the principle that there must have been something present in those teachings to suggest to one skilled in the art that the claimed invention before the court would have been obvious. *In re Bergel*, 292 F.2d 955, 956-57, 130 USPQ 206, 208 (CCPA 1961); *In re Sponnoble*, 405 F.2d 578, 585, 160 USPQ 237, 244 (CCPA 1969).

The court's pairing of Sumitomo and Markwood disregarded, as above indicated, the undisputed evidence that the unsintered PTFE of Sumitomo does not respond to the conventional plastics processing of Markwood and the art recognition of that fact. *Whiton*, supra, 420 F.2d at 1085, 164 USPQ at 457.

In evaluating claim 19, for example, the pairing disregarded Sumitomo's limited *312 length of stretch teaching. In evaluating claim 3, the court recognized that Sumitomo made no mention of rate of stretch. Looking to Markwood to supply that teaching disregarded not only the conventional plastics-unsintered PTFE distinction but also the clear divergence of Markwood's teaching that crystallinity must be reduced or avoided from the presence of "highly crystalline" in all claims of the '566 patent.

Similarly, and for many of the same reasons, the pairing of Markwood's and Smith's teachings was an inappropriate basis for concluding that the processes set forth in claims 3 and 19 would have been obvious. As above indicated, Markwood's rapid stretching of conventional plastic polypropylene with reduced crystallinity would not suggest rapid stretching of highly crystalline PTFE, in light of teachings in the art that PTFE should be stretched slowly. The Smith patent is owned by du Pont, where Dr. Gore's process invention was considered to have produced a "remarkable new material." That circumstance is not surprising, for Smith, though dealing with PTFE, says not a word about any rate of stretch.

Lastly, the pairing of Sumitomo and the 915 patent suffers from the same shortcomings. The pairing resulted from a hypothetical set forth in Garlock's post trial brief, and was based on no testimony or other evidence in the record. In respect to claim 3, neither reference mentions rate of stretch or suggests its importance. In respect of claim 19 both references point away from the claimed invention in their limited length-of-stretch teachings. The 915 patent states: "the 65 percent expanded material could be expanded a second time for an additional 65 percent expansion or a total length increase ratio of 1:2.72 [less than three times the original length]. However, great care was necessary to obtain a uniformly expanded material at these very great expansion ratios." Thus the 915 patent suggests that the amount of stretch of 500% set forth in claim 19 (more than five times the original length) is not possible.

As indicated, Sumitomo and Smith are totally silent respecting the rate of stretch, and there is simply no teaching in the art that would suggest to one of ordinary skill that Markwood's fast stretching of other thermoplastics could or should be employed in the process of treating PTFE taught by either Sumitomo or Smith. Indeed, Smith not only says nothing about rate of stretch, its preferred teaching is away from other elements of the inventions set forth in claims 3 and 19. Smith discloses that stretching should be done after the PTFE is heated above its crystalline melting point and with decreased crystallinity. Smith teaches:

Below about 300 degreesC it is not possible to draw more than about 4X [times] and while such draw ratios can be attained around 300 degreesC and below the polymer's crystalline melting point with resultant orientation and improved properties it is preferred to use temperatures at or above the polymer's crystalline melting point. (Emphasis

added).

Nash teaches that the film should be plasticized, i.e., made more viscous, before stretching. Contrary to that teaching, Dr. Gore did not reduce crystallinity before increasing the rate of stretch, but maintained the unsintered PTFE "highly crystalline" while stretching at a 100% per second rate and to more than five times, as set forth respectively in claims 3 and 19.

[16] On the entire record and in view of all the references, each in its entirety, it is clear that a person of ordinary skill confronted with a PTFE tape breakage problem would have either slowed the rate of stretching or increased the temperature to decrease the crystallinity. Dr. Gore did neither. He proceeded contrary to the accepted wisdom of the prior art by dramatically increasing the rate and length of stretch and retaining crystallinity. That fact is strong evidence of nonobviousness. *United States v. Adams*, 383 U.S. 39 (1966).

Having learned the details of Dr. Gore's invention, the district court found it within the skill of the art to stretch other material rapidly (Markwood); to stretch PTFE to increase porosity (Sumitomo); and to stretch at high temperatures (Smith). The result is that the claims were used as a frame, and individual, naked parts of separate prior art references were employed as a mosaic to recreate a facsimile of the claimed invention. At no point did the district court, nor does Garlock, explain why that mosaic would have been obvious to one skilled in the art in 1969, or what there was in the prior art that would have caused those skilled in the art to disregard the teachings there found against making just such a mosaic. On the contrary, the references and the uncontested testimony, as above indicated, established that PTFE is *sui generis*. It is not surprising, therefore, that, unlike the situation in *Stratoflex, Inc. v. Aeroquip Corp.*, 218 USPQ 871 (Fed. Cir. 1983), there was no testimony and no finding that one skilled in the art would transfer conventional thermoplastic processes to those for unsintered PTFE, or would have been able to predict what would happen if they did.

[17] To imbue one of ordinary skill in the art with knowledge of the invention in suit, *313 when no prior art reference or references of record convey or suggest that knowledge; is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher.

[18] It is difficult but necessary that the decisionmaker forget what he or she has been taught at trial about the claimed invention and cast the mind back to the time the invention was made (often as here many years), to occupy the mind of one skilled in the art who is presented only with the references, and who is normally guided by the then-accepted wisdom in the art. Had that been here done the inventions set forth in the claims 3 and 19 of the '566 patent could only have been held non-obvious to those skilled in the art at the time those claimed inventions were made.

[19] Error in visualizing the burden of proof on obviousness may have contributed to the court's application here of the prior art. Adopting the phrase from earlier precedents, the court said "the presumption [of validity] is weakened greatly where the Patent Office has failed to consider pertinent prior art." That is not the law of established precedent in this court. *SSIH Equipment S.A. v. ITC*, 218 USPQ 678, 687 (Fed. Cir. 1983); *Solder Removal Co. v. ITC*, 582 F.2d 628, 633, 199 USPQ 129, 133, n. 9 (CCPA 1978). The presumption has no separate evidentiary value. It cautions the decisionmaker against a rush to conclude invalidity. Submission of additional art that is merely "pertinent" does not dispel that caution. It is difficult to imagine a patent law suit in which an accused infringer is unable to add some new "pertinent" art. The inescapable burden of persuasion on one who would prove invalidity, however, remains throughout the trial. 35 U.S.C. §282.

[20] The burden of proving invalidity may of course be facilitated by prior art that is more pertinent than that considered by the PTO. That did not happen here. In the present case, Sumitomo, Smith, and the '915 patent were among references considered by the PTO. Other references referred to as not considered were merely cumulative, disclosing nothing not disclosed in references that were considered by the PTO. The Canadian counterpart of Nash was considered by the PTO. The relevant disclosures of Markwood appear in Sandiford patent 3,544,671 and Paratheon patent 3,637,906, both considered by the PTO. The Russian Author's Certificate 240,997, assuming its status as prior art and whatever the material with which it dealt, contributed nothing beyond the teachings of the '915 patent considered by the PTO.

[21] As discussed more fully below, the district court erred in specifically declining to consider the

objective evidence of nonobviousness. In *re Sernaker*, 702 F.2d 989, 996, 217 USPQ 1, 7 (Fed. Cir. 1983). That evidence can often serve as insurance against the insidious attraction of the siren hindsight when confronted with a difficult task of evaluating the prior art. Though the prior art evidence here pointed more in the direction of nonobviousness than obviousness, the objective evidence may tend, as it did in *Sernaker*, supra, to reassure the decisionmaker.

In sum, the district court erred as a matter of law on this record in concluding that Garlock had met its burden of proving that the inventions of claims 3 and 19 of the '566 patent would have been obvious.

(b) '390 patent

(i) §102

The district court found product claims 1, 9, 12, 14, 18 and 43 inherently anticipated because it found that the microstructure of nodes interconnected by fibrils is an inherent characteristic of paste-extruded PTFE products resulting from the process disclosed in Smith. The court found the first four of those claims and claim 43, plus claims 35, 36, 67 and 77 inherently anticipated because high strength PTFE products are inherent in the examples of Sumitomo.

The teachings of Smith include neither a disclosure nor a suggestion of "porous" products having a "microstructure characterized by nodes interconnected by fibrils" as required by the claims found to have been anticipated by Smith.

The teachings of Sumitomo do not include a disclosure of products having "a matrix tensile strength * * * above about 7,300 psi" as required by the claims found to have been anticipated by Sumitomo.

[22] Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration. *Soundsciber Corp. v. U.S.*, 360 F.2d 954, 960, 148 USPQ 298, 301, adopted, 149 USPQ 640 (Ct. Cl. 1966). Neither Smith nor Sumitomo disclose an invention set forth in any claim of the '390 patent.

The incongruity in findings that the different processes of Smith and Sumitomo each inherently produced identical products is striking.

Garlock attempted with expert testimony to overcome

the prior art shortcomings as proof of anticipation. Gore rebutted with its own expert testimony. It is unnecessary, however, to resolve apparent conflicts in the divergent testimony, much if not all of which took *314 the form of pure unsupported assertion. No inter partes tests in which the Smith and Sumitomo processes were conducted are of record. No products of those processes were placed in evidence, and there was, of course, no analysis of any such evidentiary products.

Nor is it necessary to evaluate the inappropriate disparagement in Garlock's brief of Dr. Sperati as a "friend" of Gore.

[23] Given the unique nature of unsintered PTFE, we are not persuaded that the "effect" of the processes disclosed in Smith and Sumitomo, an "effect" undisclosed in those patents, would be always to inherently produce or be seen always to produce products meeting all of the claim limitations. Anticipation of inventions set forth in product claims cannot be predicated on mere conjecture respecting the characteristics of products that might result from the practice of processes disclosed in references. In re Felton, 484 F.2d 495, 500, 179 USPQ 295, 298 (CCPA 1973). It is clear that the teachings of neither Smith nor Sumitomo place the products claimed in the '390 patent in possession of the public.

The teachings of Smith and Sumitomo are so unacceptably vague concerning characteristics of products produced by their respective processes as not to support an anticipation rejection. That fact is confirmed by the PTO's having fully considered those references and by its having issued the '390 patent over them.

[24] Garlock's assertion that it employs a process covered by the Smith patent, if true, is irrelevant. The '390 patent was allowed over Smith as a reference. Assuming Smith is a dominating patent, the rule of law is clear that an accused infringer's employment of the process of a dominating patent does not render that employment an anticipation of an invention described and claimed in an improvement patent. As indicated, there is no present record basis for finding that the Smith process in itself necessarily and inherently results in the products, each considered in its entirety, in the claims of the '390 patent. The testimony of Garlock's expert about ex parte tests, the records of which he destroyed before trial, cannot serve as such a basis. The effusive praise of Dr. Gore's claimed products by the owner of the Smith

patented process would appear, on the contrary, to confirm the action of the PTO in issuing the '390 patent.

Garlock has not met its burden of showing that claims 1, 9, 12, 14, 18, and 43 are anticipated by Smith or that claims 1, 9, 12, 14, 35, 36, 43, 67, and 77 are anticipated by Sumitomo.

(ii) §103

[25] The scope and content of the prior art and level of ordinary skill, discussed above in relation to the '566 patent, would be the same for the '390 patent. The district court did not, however, nor does Garlock, apply the Graham criteria, supra, to the '390 claims, apparently assuming that the claimed products, having been found inherent in the processes of Sumitomo and Smith, would have been obvious in view of those references. If so, that was error. Inherency and obviousness are distinct concepts. In re Spormann, 363 F.2d 444, 448, 150 USPQ 449, 452 (CCPA 1966).

In discussing inherency the district court did recognize differences between Smith's disclosure and the inventions set forth in claims 1, 9, 12, 14, 18, and 43, i.e., the absence from Smith of a description of the products of Smith's process as porous and the absence from Smith of a disclosure that those products have a microstructure characterized by nodes interconnected by fibrils.

Similarly, a difference between Sumitomo's disclosure and the inventions set forth in claims 1, 9, 12, 14, 35, 36, 43, 67, and 77 was recognized in the absence from Sumitomo of a quantification of the matrix tensile strengths of the products of Sumitomo's process. The district court also discussed differences between the dependent claims and the prior art. Because we conclude that the independent claims of the '390 patent are patentable over the art of record, we need not discuss the dependent claims.

[26] Having determined that the invention would have been obvious in view of the process of either Smith or Sumitomo, the district court did not discuss the strong showing of objective evidence of nonobviousness here present, saying with respect to one part of such evidence, "no amount of commercial success can save it." That approach was error. All evidence bearing on the issue of obviousness, as with any other issue raised in the conduct of the judicial process, must be considered and evaluated before the required legal conclusion is reached. Stratoflex,

supra, 218 USPQ at 879.

[27] The objective evidence of nonobviousness, i.e., the "indicia" of Graham, supra, may in a given case be entitled to more weight or less, depending on its nature and its relationship to the merits of the invention. It may be the most pertinent, probative, and revealing evidence available to aid in reaching a conclusion on the obvious/nonobvious issue. It should when present always be considered as an integral part of the analysis.

Gore's fabric laminates, for example, as set forth in claims 36 and 77, satisfied a long-felt *315 need for a material having the contradictory properties of being simultaneously breathable (allowing water vapor or perspiration to pass) and waterproof. The record establishes that such a material had long been sought by makers of rainwear and outerwear, and by the U.S. Army as well. That Gore's fabric laminates filled that need is attested by the rise in their annual dollar sales from zero to seven million in the first five years of their availability.

Gore's PTFE tubes for replacement of human arteries and veins, also satisfied a long-felt need. The uncontradicted evidence establishes that Gore's PTFE tubes hold blood without leaking, need not be pre-clotted with the patient's blood, are chemically inert, and, being breathable, are less likely to cause an air embolism. The value and uniqueness of those four properties make Gore's PTFE tubes, as described in unchallenged testimony, "the most important synthetic material presently existing" in vascular surgery, and, along with other evidence in the record, reflect the intended working of the patent system.

As discussed above, current annual sales of over sixty million dollars are attributable to the merits of the products claimed in the '390 patent. Considering the long-felt need for those products and the obvious commercial advantage to be gained by meeting that need, it is reasonable to conclude that the claimed products of the '390 patent would not have been obvious to persons of ordinary skill in the art at the time the claimed inventions were made.

[28] As above indicated, the praise which greeted the products claimed in the '390 patent from PTFE suppliers, including the owner of the Smith patent, is further objective evidence of nonobviousness.

[29] Garlock's appeal argument that the '390 claims are invalid because the recited minimum matrix

tensile strengths are not "critical" is without merit. A claim to a new product is not legally required to include critical limitations. In re Miller, 441 F.2d 689, 696, 169 USPQ 597, 602 (CCPA 1971). The '390 claims are not drawn to optimization of ingredients or ranges within broad prior art teachings, but to new porous PTFE products of particular characteristics.

In sum, and in view of the difficulty of working with unsintered PTFE and its unpredictable response to various processing techniques, the vagueness of Smith and Sumitomo concerning the products produced by those processes, the filling of at least two long-felt needs and the commercial success described above, we conclude that the inventions set forth in claims 1, 9, 12, 14, 18, 35, 36, 43, 67, and 77 of the '390 patent would not have been obvious to those skilled in the art at the time those inventions were made.

(c) §112 and the '566 and '390 patents

The patents in suit resulted from a single application and thus have substantially identical specifications. The holding of invalidity on the basis of §112 is common to both patents.

The district court found that the patents did not disclose sufficient information to enable a person of ordinary skill in the art to make and use the invention, as required by §112, first paragraph, and that certain claim language was indefinite, presumably in light of § 112, second paragraph, because: (1) there was no definition in the specification of "stretch rate," different formulae for computing stretch rate having been developed and presented at trial; (2) there was no way taught in the specification to calculate the minimum rate of stretch above 35 degreesC; (3) the phrase "matrix tensile strength" is indefinite; and (4) the phrase "specific gravity of the solid polymer" is indefinite.

[30] The findings rest on a misinterpretation of §112, its function and purpose. The district court considered whether certain terms would have been enabling to the public and looked to formula developments and publications occurring well after Dr. Gore's filing date in reaching its conclusions under § 112. Patents, however, are written to enable those skilled in the art to practice the invention, not the public. In re Storrs, 245 F.2d 474, 478, 114 USPQ 293, 296-97 (CCPA 1957), and §112 speaks as of the application filing date, not as of the time of trial. In re Mott, 539 F.2d 1291, 1296, 190 USPQ

536, 541 (CCPA 1976). There was no evidence and no finding that those skilled in the art would have found the specification non-enabling or the claim language indefinite on May 21, 1970, when the application which resulted in issuance of Dr. Gore's patents was filed. Indeed, the expert quoted by the district court and whose testimony was primarily relied upon respecting formulae, was still in school at that time.

There is uncontradicted evidence in the record that at the time the application was filed "stretch rate" meant to those skilled in the art the percent of stretch divided by the time of stretching, and that the latter was measurable, for example, with a stopwatch. Concern for the absence from the specification of a formula for calculating stretch rate is therefore misplaced, and the post-filing date development of varying formulae, including Dr. Gore's later addition of a formula in his corresponding Japanese patent, is irrelevant.

[31] *316 Section 112 requires that the inventor set forth the best mode of practicing the invention known to him at the time the application was filed. Calculating stretch rate at that time was accomplished by actually measuring the time required to stretch the PTFE material. That was the only mode then used by the inventor, and it worked. The record establishes that calculation by that mode would have been employed by those of ordinary skill in the art at the time the application was filed. As indicated, Dr. Gore's disclosure must be examined for §112 compliance in light of knowledge extant in the art on his application filing date.

[32] The district court, though discussing enablement, spoke also of indefiniteness of "stretch rate," a matter having to do with §112, second paragraph, and relevant in assessment of infringement. The use of "stretching * * * at a rate exceeding about 10% per second" in the claims is not indefinite. Infringement is clearly assessable through use of a stopwatch. No witness said that could not be done. As above indicated, subsequently developed and therefore irrelevant formulae cannot be used to render non-enabling or indefinite that which was enabling and definite at the time the application was filed.

[33] Similarly, absence from the specification of a method for calculating the minimum rate of stretch above 35 degreesC does not render the specification non-enabling. The specification discloses that "[t]he lower limit of expansion rates interact with

temperature in a roughly logarithmic fashion, being much higher at higher temperatures." Calculation of minimum stretch rate above 35 degreesC is nowhere in the claims, and it is the claimed invention for which enablement is required. The claims require stretching at a rate greater than 10% per second at temperatures between 35 degreesC and the crystalline melt point of unsintered PTFE. That the minimum rate of stretch may increase with temperature does not render non-enabling Dr. Gore's specification, particularly in the absence of convincing evidence that those skilled in the art would have found it non-enabling at the time the application was filed.

[34] The district court invalidated both patents for indefiniteness because of its view that some "trial and error" would be needed to determine the "lower limits" of stretch rate above 10% per second at various temperatures above 35 degreesC. That was error. Assuming some experimentation were needed, a patent is not invalid because of a need for experimentation. *Minerals Separation, Ltd. v. Hyde*, 242 U.S. 261, 270-71 (1916). A patent is invalid only when those skilled in the art are required to engage in undue experimentation to practice the invention. *In re Angstadt*, 537 F.2d 498, 503-04, 190 USPQ 214, 218 (CCPA 1976). There was no evidence and the court made no finding that undue experimentation was required.

[35] Moreover, the finding here rested on confusion of the role of the specification with that of the claims. The court found that the specification's failure to state the lower limit of stretch rate (albeit above 10% per second) at each degree of temperature above 35 degreesC (a requirement for at least hundreds of entries in the specification) did not "distinguish processes performed above the 'lower limit' from those performed below the 'lower limit'." The claims of the '390 patent say nothing of processes and lower limits. Distinguishing what infringes from what doesn't is the role of the claims, not of the specification. It is clear that the specification is enabling, *In re Storrs*, supra, and that the claims of both patents are precise within the requirements of the law. *In re Moore*, 439 F.2d 1232, 169 USPQ 236 (CCPA 1971).

[36] The finding that "matrix tensile strength" is indefinite, like the other findings under §112, appears to rest on a confusion concerning the roles of the claims and the specification. While finding "matrix tensile strength" in the claims indefinite, the

district court at the same time recognized that the specification itself disclosed how to compute matrix tensile strength, in stating "to compute matrix tensile strength of a porous specimen, one divides the maximum force required to break the sample by the cross sectional area of the porous sample, and then multiplies this quantity by the ratio of the specific gravity of the solid polymer divided by the specific gravity of the porous specimen." Further, the specification provided the actual matrix tensile strength in several examples. It is well settled that a patent applicant may be his own lexicographer. In light of the disclosure of its calculation in the specification, we cannot agree that "matrix tensile strength" is either indefinite or non-enabling.

Nor does absence from the specification of a definition for "specific gravity of the solid polymer," a part of the computation of matrix tensile strength, render that computation indefinite. It is undisputed that in the many examples in the application the specific gravity values used for unsintered and sintered PTFE were 2.3 and 2.2, respectively. There was no testimony that those values were not known to persons of ordinary skill in the art or could not be calculated or measured. There is simply no support for the conclusion that "specific gravity of the solid polymer" is indefinite or that absence of its definition renders *317 the specification non-enabling. See *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976).

We conclude that Garlock has failed to prove that at the time the application was filed, the specification was not enabling or that the claims were indefinite within the meaning of §112.

(2) Fraud

[37] Fraud must be shown by clear and convincing evidence. *Norton v. Curtiss*, 433 F.2d 779, 797, 167 USPQ 532, 546-47 (CCPA 1970).

The state of mind of the one making the representations is probably the most important of the elements to be considered in determining the existence of "fraud." * * * Good faith and subjective intent, while they are to be considered, should not necessarily be made controlling. Under ordinary circumstances, the fact of misrepresentation coupled with proof that the party making it had knowledge of its falsity is enough to warrant drawing the inference that there was a fraudulent intent. Where public policy demands a complete and accurate disclosure it may suffice to show nothing more than that the misrepresentations

were made in an atmosphere of gross negligence as to their truth. [emphasis in original].

Norton, 433 F.2d at 795-96; 167 USPQ at 545; see, *Miller*, *Fraud on the PTO*, 58 JPOS 271 (1976).

Garlock alleges fraud in Gore's representations that stretching PTFE tape at a rate greater than 10% per second was novel and that it produces a physical phenomenon. The district court found the evidence insufficient to establish that Gore had a specific intent to defraud the PTO. No basis exists for our overturning that finding. Accordingly, we agree with the district court that Garlock has failed to sustain its heavy burden of proving, by clear and convincing evidence, sufficient facts from which fraudulent intent can be inferred.

Garlock points to a September 4, 1975, Gore affidavit filed in the PTO that stated:

2. Prior to my invention disclosed in the captioned patent application, during production of expanded PTFE products by W. L. Gore & Associates, Inc., the rate of stretching was neither measured nor controlled and to my knowledge did not involve stretching of unsintered PTFE at a rate exceeding about 10% per second. (emphasis in original)

No finding of the district court and no evidence of record establishes that that statement was made in reckless disregard of facts from which an intent to defraud may be inferred.

The district court's finding in 1982 that the 401 machine inherently stretched tape at some time in 1969 at a rate more than 10% per second, does not establish that Dr. Gore was aware of that fact in 1975, nor does it make untrue his statement that to his knowledge that had not been the rate of stretch employed. Nor does the district court's finding conflict with Dr. Gore's statement that the rate of stretching was neither measured nor controlled in the Gore shop before his invention of the claimed process as a whole.

Nor does the evidence of isolated statements support Garlock's contention that Dr. Gore attempted to convince the PTO that a physical phenomenon always existed in which stretching at a rate greater than 10% per second always produced a matrix tensile strength greater than 7300 psi. On the contrary, Dr. Gore set forth in his specification examples indicating that some samples broke, ruptured, or disintegrated.

(3) Attorney's Fees

The district court did not abuse its discretion in denying Garlock its request for attorney fees.

Infringement

[38]. Where, as here, an appellate court reverses a holding of invalidity, and remand is ordered for trial of the factual issue of infringement, an inefficient use of judicial resources results if the second judgment is appealed. The better practice would therefore be for the district court to decide both the validity and infringement issues when both are contested at the trial, enabling the conduct of a single appeal and disposition of the entire case in a single appellate opinion.

Resolution of the infringement issue at trial may also overlap with resolution of the validity issue, where, for example, the claimed invention was or was not copied by the validity challenger, or the challenger substituted the claimed invention for freely available prior art processes or products, Eibel, supra, 261 U.S. at 56, or an assertion of nonenablement may conflict with the ease with which the accused infringer may be shown to have practiced the invention as taught in the patent. Eibel Process Co. v. Minnesota & Ontario Paper Co., 261 U.S. 45, 61 (1923).

[39] The district court having declined to decide the infringement issue, Gore suggests that the record here is sufficient to warrant *318 our deciding it now. With reluctance in view of the length and bitter nature of the present litigation, we decline the suggestion. In so doing, we imply nothing of our view on the issue. Nor do we intend any implication that the district court could not itself determine the infringement issue on the present record. Infringement of particular claims of two patents was asserted. None of those claims has been finally held invalid. Assuming their continued assertion, infringement must be decided with respect to each asserted claim as a separate entity. Altoona, supra, 294 U.S. at 487. Those factual determinations should be made in the first instance by the district court.

Decision

The holdings of invalidity of claim 1 of the '566 patent under §102(a) and of claim 17 of the '566 patent under §103, the determination that Gore did not commit fraud on the PTO, and the denial of attorney fees, are affirmed; the holdings that all claims of the '566 patent are invalid under §102(b), that claims 3 and

19 of the '566 patent are invalid under §103, and that all claims of the '566 patent are invalid under §112, are reversed. The holdings that claims 1, 9, 12, 14, 18, 35, 36, 43, 67, and 77 of the '390 patent are invalid under §§102 and 103, and that all claims of the '390 patent are invalid under § 112, are reversed. The case is remanded for determination of the infringement issue.

Affirmed in part, reversed in part, and remanded.

APPENDIX

Appendix

Claims of the '566 patent discussed at trial:

1. A process for the production of a porous article of manufacture of a polymer of tetrafluoroethylene which process comprises expanding a shaped article consisting essentially of highly crystalline poly (tetrafluoroethylene) made by a paste-forming extrusion technique, after removal of lubricant, by stretching said unsintered shaped article at a rate exceeding about 10% per second and maintaining said shaped article at a temperature between about 35 degreesC. and the crystalline melt point of said tetrafluoroethylene polymer during said stretching.

3. The process of claim 1 in which the rate of stretch is about 100% per second.

17. The process of claim 1 in which the shaped article is expanded such that its final length in the direction of expansion is greater than about twice the original length.

19. The process of claim 17 in which said final length is greater than about five times the original length.

Claims of '390 patent discussed at trial:

1. A porous material consisting essentially of highly crystalline polytetrafluoroethylene polymer, which material has a microstructure characterized by nodes interconnected by fibrils and has a matrix tensile strength in at least one direction above about 73,00 psi.

9. A porous material consisting essentially of polytetrafluoroethylene polymer, which material has a microstructure characterized by nodes interconnected by fibrils and has a matrix tensile strength in at least one direction above 9290 psi, which material has been heated to a temperature

above the crystalline melt point of said polymer and has a crystallinity below about 95%.

12. A porous material in accordance with claim 9 which is in the form of a shaped article.

14. A product in accordance with claim 12 which is in the form of a film.

18. A product in accordance with claim 12 which is in the form of continuous filaments.

35. A laminated structure comprising (a) a first shaped article formed of a porous material made of a tetrafluoroethylene polymer, which material has a microstructure characterized by nodes interconnected by fibrils and has a matrix tensile strength in at least one direction above about 7,300 psi, and (b) a second shaped article bonded to said first shaped article.

36. The structure of claim 35 in which said first shaped article is formed of a porous material which has a matrix tensile strength in at least one direction of at least 9290 psi, and has a crystallinity below about 95%.

43. A porous material made of a tetrafluoroethylene polymer, which material has a microstructure characterized by nodes interconnected by fibrils, which material (a) has a matrix tensile strength in at least one direction above about 9290 psi, (b) has been heated to a temperature above 327 degrees C. and has a crystallinity below about 95%, and (c) has a dielectric constant of 1.2-1.8.

67. An impregnated structure comprising

(a) a shaped article formed of a porous material made of a tetrafluoroethylenepolymer which material has a microstructure characterized by nodes interconnected by fibrils and a matrix tensile strength in at least one direction above about 9290 psi, and

*319 (b) a polymer impregnated within the pores of the said shaped article.

77. The structure of claim 35 in which the first shaped article is a sheet having pores that will pass a gas but will not pass liquid water.

FN1 35 U.S.C. §102(a) and (b) provide:

A person shall be entitled to a patent unless --

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or * * *35 U.S.C. §103 provides:

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.35 U.S.C. §112 provides:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention. A claim may be written in independent or dependent form, and if in dependent form, it shall be construed to include all the limitations of the claim incorporated by reference into the dependent claim.

Davis, Circuit Judge, concurring in the result in part and dissenting in part.

I concur in the result on (1) the validity of the '390 patent under §§ 102-103; (2) the validity of the '390 patent under §112; (3) the invalidity of claims 1 and 17 of the '566 patent; (4) lack of fraud on the Patent and Trademark Office; and (5) denial of attorneys' fees. I disagree and dissent as to the validity of claims 3 and 19 of the '566 patent.

1. The process invention embodied in claim 1 of the '566 patent was known, through use of the 401

machine in the Gore shop, well before the "invention date" (claimed by Robert Gore, the inventor) of October 1969. [FN1] As such, the claimed invention was invalid on at least three grounds: (i) it was anticipated and therefore would have been obvious (under 35 U.S.C. §103) at the time of the claimed invention date; (ii) the invention was "in public use" by the Gore shop (under 35 U.S.C. §102(b)) more than one year prior to the patent application (i.e., prior to May 21, 1969); and (iii) the invention (made by Robert Gore) was known to and used "by others in this country" (35 U.S.C. § 102(a)) before the claimed invention date of October 1969, i.e. the invention was used by Wilbert Gore and others in the Gore shop before the October date. [FN2]

The critically important aspect of the invention of the '566 patent is the stretching of PTFE at a rate above 10% per second. [FN3] Robert Gore testified that he conceived this invention no earlier than October 1969 (and we have the right to take him at his word), [FN4] but the facts found by the District Court plainly show that the Gore shop was in fact practicing that invention considerably earlier.

The District Court found that in the 401 machine the distance between the stretch rollers controls the rate of stretch; a shorter distance results in a higher rate of stretch; for the process described in the '915 patent to be practiced with a rate of stretch below 10% per second, the distance between the stretch rollers would have to be greater than five feet; if the distance is less than four feet, the rate of stretch is greater than 10% per second; the machine drawings used to construct the 401 machine indicate that the distance between the stretch rollers was eight inches; a Gore employee testified that "I am reasonably sure that no effective [stretch] rolls in question would have been more than three feet simply because of the nature and size of the equipment" and that he did not remember any stretching more than three feet; another Gore employee testified that the distance between the rollers was "a maximum of 18 inches" (emphasis added); a document prepared by the same employee (an engineer) on June 10, 1969 reports that the stretch span was 8 inches; the 401 machine was the only stretching machine used by the Gore company; and the 401 machine was never substantially changed before October 1969. All this adds up to the fact that the 401 machine was at all relevant times operated with a stretch of less than four feet. [FN5] There is no question that the machine was so operated before October 1969 (the District Court found that sales of tape made by the 401 machine were proposed in August 1969).

I can accept Robert Gore's affidavit (to the PTO) that there was no stretching in the Gore shop at a rate exceeding about 10% per second prior to "my invention disclosed in the captioned patent application" (emphasis added) [FN6] only because that declaration was expressly qualified by the phrase "to my knowledge" (emphasis added). The District Court specifically found no specific intent by Robert Gore to defraud and, on this record, we *320 cannot properly overturn that finding. But the absence of personal intent to defraud does not mean or say that, whether Robert Gore realized it or not, the 401 machine was not actually operating, well before October 1969, to stretch unsintered PTFE at a rate exceeding about 10% per second. Cf. *O'Brien v. Westinghouse Electric Corp.*, 293 F.2d 1, 10 (3rd Cir. 1961). It seems impossible to me to reconcile Robert Gore's insistence on two facts-- that (i) he invented the process in October 1969 and (ii) he had no knowledge prior to October 1969 of stretching PTFE at the critical rate-- with the solid facts in the record as to the prior operation of the 401 machine, except on the view that Robert Gore did not realize that he and others in the Gore shop had made his invention previously.

2. It follows that in October 1969 the invention of '566 would have been obvious under §103 to Robert Gore because the prior practice of the 401 machine constituted prior art. Even if this was not prior art technically within §102, that statutory provision "is not the only source of prior art." *In re Fout*, 675 F.2d 297, 300 (CCPA 1982, emphasis in original). The 401 machine was practiced under the '915 patent (issued to Wilbert Gore) and, whether or not Robert Gore subjectively realized what was happening, he and others in the Gore shop were practicing the invention later embodied in the '566 patent. That was prior art at least as to Robert Gore. *Id.* at 300-01. [FN7]

3. If it be thought necessary to invoke §102 directly, in order to show anticipation, the record contains proof that the 401 machine was designed, constructed and used (just as described supra) in November and December 1968 and the early months of 1969--more than one year prior to the '566 patent application of May 21, 1970. See *Jt. App. E 1199-E 1200*. Section 102(b) therefore applies. Although commercial production was apparently not actively sought until June 1969, the practicing of the 401 machine prior to May 21, 1969 was "a public use" because the Gore company made "use of the device * * * in the factory in the regular course of business." *Connecticut Valley Enterprises, Inc. v. United States*, 348 F.2d 949, 952,

146 USPQ 404, 406 (Ct. Cl. 1965).

4. Also, §102(a) [FN8] applies here because Robert Gore was the inventor in the '566 patent and Wilbert Gore and others in the Gore shop were using the 401 machine before October 1969. Wilbert Gore (the inventor in the '915 patent under which the 401 machine was made and used) and the other employees are "others" within §102(a)--they are not the same as Robert Gore who claimed to be inventor of the process that ripened into the '566 patent. [FN9] See also § 102(f), which would bar Robert Gore if he did not himself invent the subject matter of the '566 patent. [FN10]

5. The majority sustains the validity of claims 3 and 19 of the '566 patent (the claims also involved in appellant's suit for infringement) which are dependent on invalid claim 1. Because of the invalidity of claim 1 the only possible novelty in claim 3 would be the requirement that the rate of stretch would be about 100% per second, and the possible novelty of claim 19 would be that the final length would be greater than about five times the original length. My position is that both of these added elements, if novel, would have been obvious to persons of ordinary skill in the art.

The defect in the majority's analysis is that it neglects the cardinal fact that the prior art included the 401 machine (discussed supra), not merely the earlier patents assessed in the majority opinion. The 401 machine directly involved PTFE itself, not conventional thermoplastic polymers. That machine also directly involved rapid stretching of PTFE at a rate markedly exceeding 10%. With this prior art of the 401 machine before him, an ordinary person skilled in the art would maximize stretch rate, if only to improve the machine's production rate. Cf. *In re Dwyer, Jewell, Johnson, McGrath, & Rubin*, 317 F.2d 203, 207, 137 USPQ 540 (CCPA 1963). Moreover, the very existence and operation of the 401 machine, which stretched PTFE rapidly without breaking, suggests to the skilled person the probability of stretching at even higher rates. Certainly, in the light of the 401 machine, skilled workers would see in at least *321 the prior Markwood, Nash, and Scarlett patents (teaching extensive and rapid stretching of non-PTFE thermoplastics) the suggestion that the method of the 401 machine could also be used for comparable rapid and extensive stretching of PTFE.

6. In sum, I cannot escape the conclusion that--although there was no fraud proved--if the true facts as to the 401 machine had been made known to the PTO

(as it requested), the involved claims of the '566 patent should (and probably would) not have been accepted.

FN1 The 401 machine was used under the prior '915 patent (issued to Wilbert Gore) which contains no reference to the significance of the rate of stretch.

FN2 Aside from the bases I discuss, I do not reach the other grounds asserted for invalidity of the '566 patent.

FN3 Before the PTO Robert Gore concededly referred to this as "critical" to his invention or as his "invention."

FN4 The District Court found that October 1969 was the earliest date Robert Gore asserts for his conception of the invention in the '566 patent.

FN5 The Gores (Robert and Wilbert) testified at trial that the distance was five feet but there is no indication that the trial court (which did not cite this testimony but did cite the opposing evidence) credited the Gores' testimony.

FN6 The factor of the rate of stretching was of direct interest to the examiner during the prosecution of the '566 patent. In response to the examiner's express request for a declaration that the Gore firm's production of stretched PTFE tape, prior to Robert Gore's invention asserted here, did not involve stretching of unsintered PTFE at a rate exceeding about 10% per second, Robert Gore filed an affidavit in the PTO specifically stating that "to my knowledge" (emphasis added) the 401 machine did not involve stretching at a rate exceeding about 10% per second.

FN7 The District Court has found that there are no differences between claim 1 of the '566 patent and the processes previously used by the Gore firm to produce paste-extruded unsintered PTFE.

FN8 An invention is anticipated if it "was known or used by others in this country * * * before the invention thereof by the applicant for patent" (emphasis added).

FN9 It is undisputed that it was Wilbert Gore who initiated the project for the 401 machine and watched over it.

FN10 The majority's discussion of "secondary considerations," though it is relevant to other aspects of this case, is irrelevant to the issue of anticipation raised by the 401 machine, and hardly persuasive as to the issues of obviousness based on or with respect to the 401 machine.

Appendix 19:

In re McLaughlin, 443 F.2d 1392, 170 U.S.P.Q. 209 (C.C.P.A. 1971).

C

In re McLaughlin

Court of Customs and Patent Appeals

No. 8474

Decided June 24, 1971

United States Patents Quarterly Headnotes

PATENTS

[1] Patentability -- Anticipation -- Combining references (§ 51.205)

Test for combining references is not what individual references themselves suggest but rather what the combination of disclosures taken as a whole would suggest to one of ordinary skill in the art.

PATENTS

[2] Patentability -- Invention -- In general (§ 51.501)

Any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning, but so long as it takes into account only knowledge which was within level of ordinary skill at time claimed invention was made and does not include knowledge gleaned only from applicant's disclosure, reconstruction is proper.

PATENTS

[3] Patentability -- Evidence of -- Commercial success -- In general (§ 51.4551)

Recognizing that inference of obviousness drawn from prior art disclosures is only prima facie justification for drawing ultimate legal conclusion that claimed invention is unpatentable under 35 U.S.C. 103, it is imperative that such secondary considerations as commercial success and adaptation by competitor also be evaluated in determining final validity of that legal conclusion; this is true even where claimed invention involves only relatively simple mechanical concepts.

PATENTS

Particular patents--Railway Cars

McLaughlin, Compartment Arrangement for Railway Cars, claim 15 of application allowed; claims 13 and 14 refused.

*210 Appeal from Board of Appeals of the Patent Office.

Application for patent of Gerald McLaughlin, Serial No. 566,701, filed July 5, 1966; Patent Office Group

317. From decision rejecting claims 13 to 15, applicant appeals. Affirmed as to claims 13 and 14; reversed as to claim 15.

Norman Lettvin, Chicago, Ill., for appellant.

S. Wm. Cochran (R. V. Lupo of counsel) for Commissioner of Patents.

Before Rich, Almond, Baldwin, and Lane, Associate Judges, and Re, Judge, United States Customs Court, sitting by designation.

Baldwin, Judge.

McLaughlin has appealed from the decision of the Patent Office Board of Appeals sustaining the rejection of claims 13, 14 and 15 in his application [FN1] as unpatentable under 35 U.S.C. 103 in view of the prior art. One claim has been held allowable.

The Invention

The subject matter of the claims on appeal may be characterized as an improved construction arrangement for railroad "boxcars" which are adapted for carrying "unitized" cargo. The latter term is defined by appellant as "cargo that is loaded upon a cargo-handling platform (such as a pallet or slip sheet) of a pre-selected size, and which is arranged for transfer between stations by devices such as fork-lift trucks."

Appellant states that prior art arrangements, having the doorways located substantially centrally in the opposed sidewalls, leave the center of the car unsuitable for holding additional pallets securely because side filler panels cannot be placed over the doorways without inconveniencing loading and unloading.

The present invention, as represented in Figure 2 of the application, which we reproduce below along with Figure 3, is alleged to permit a larger volume of freight to be conveniently loaded in a car with the same overall dimensions.

Image 1 (1.5 X 4) Available for Offline Print

*211

Image 2 (2.5 X 3.25) Available for Offline Print

The car used in this arrangement has the door

openings 39 (left hand occurrence) and 40 in the opposite sidewalls offset longitudinally so that each sidewall includes a long wall section and a short wall section on opposite sides of the opening. Side filler panels 43 and 45 are affixed to the interiors of the long wall sections 37 and 34, respectively, and longitudinally adjustable bulkheads 47 and 48 are provided. The car is shown completely filled with groups of palletized containers 51 and 52, secured in position by the side filler panels and bulkheads. The application describes the loading of this car as follows:

Typically, the load dividers 47 and 48 are initially moved to the left of doorway 40 to permit free access to the floor surface area in the "deep end" of the car bounded by end wall 30. The pallets 51 are placed into the car in sequence, adjusting the side fillers to the necessary width required to firmly confine the pallets in place. During this time, door 49 is already closed to form the lateral support for the six pallet stacks 51 nearest load divider 48. The load divider 48 is then moved into position against the stacked pallets 51 and locked in place. The second load divider 47 is then temporarily positioned closely adjacent load divider 48 to permit free access to the "short end" of the car terminated by end wall 31. Pallets 52 are then sequentially placed in position, adjusting the side fillers 45 to retain these pallets against lateral shifting. The three side fillers in the series 45 which are closest to the load divider 47 are preadjusted prior to loading the six pallet stacks 52 nearest load divider 47. Finally, load divider 47 is moved into tight engagement with the stacked pallets 52, locked in place, and the door 50 is closed to secure the pallets 52.

The only independent claim on appeal is claim 13 which we reproduce as follows:

13. An improved car-loading construction for use in elongated, wall- enclosed railway cars of the type utilizing therein longitudinally movable load-confining transverse bulkheads which are adapted to be located generally centrally of the ends of the car to project across substantially the entire width of the car;

said improved car-loading construction comprising, in combination,

the longitudinal side walls of the car each having a single doorway therein located between the ends of the wall to divide the wall into spaced long and

short sections,

the doorways being offset toward different ends of the car so that the major portion of each doorway is directly opposite the long wall section of the opposing side wall, and

side filling panels mounted on the inside surface of each of said long wall sections and being adjustable toward and away from the corresponding long wall section, so that the transversely adjustable side filling panels on one long wall section and a longitudinally adjustable transverse bulkhead may cooperate to substantially fully enclose the load in one end of the car substantially to the mid-point of the car without adversely affecting the ability to load the other end of the car.

Claim 14 adds the additional limitations that the car is adapted to carry pallet-mounted loads and the lengths of the side walls of the car conform substantially to whole multiples of a dimension of a pallet. Claim 15 further provides that the portion of each doorway directly opposite a wall is "substantially equal *212 to a plural multiple of a dimension of the pallet" and that the rest of the doorway is narrower than a pallet dimension.

The Rejection

Claims 13, 14 and 15 were rejected as unpatentable over Cook [FN2] in view of either Robertson [FN3] and Aquino [FN4] or of Lundvall, [FN5] under 35 U.S.C. 103.

Cook discloses a railway box car having sides defining oversized door openings in diagonally opposite ends of the car. That construction is described as facilitating loading and unloading lumber, permitting it to be palletized and to be handled by lift trucks.

Lundvall discloses a railway car provided with adjustable side filler panels for preventing lateral shifting of the load and adjustable bulkheads to hold the load against longitudinal shifting.

Robertson discloses a specific side filler panel construction for railway cars and Aquino is directed to a bulkhead construction for similar use.

The examiner and board based their holdings that the appealed claims are unpatentable on the view that persons of ordinary skill in the art would find it

obvious to use bulkheads and side filler panels, as disclosed in the secondary references, in connection with loads placed in a car of the Cook construction.

Opinion

Appellant has strenuously urged that the reference disclosures were improperly combined. In particular, with regard to Cook, he argues that, while the reference does show elongated, longitudinally offset doors, it does not suggest such an arrangement in combination with a bulkhead and side fillers because of the patentee's expressed desire to have a car capable of being loaded and unloaded simultaneously from both sides, which is not the desire of appellant nor even possible, he urges, with his arrangement.

[1] We have taken the above argument into consideration and do find that it has some merit. Nevertheless, it is not convincing. It should be too well settled now to require citation or discussion that the test for combining references is not what the individual references themselves suggest but rather what the combination of disclosures taken as a whole would suggest to one of ordinary skill in the

[2] art. Any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made and does not include knowledge gleaned only from applicant's disclosure, such a reconstruction is proper. The Cook patent does indicate that the car shown therein is suitable for carrying palletized loads with lift trucks being used for the loading and unloading, including stacking of the pallets. Since the secondary references show that it was well known to use side filler panels and bulkheads to confine palletized loads to prevent lateral and longitudinal shifting, we agree that those references would have suggested use of such panels and bulkheads with the Cook car for the same purpose.

[3] The foregoing conclusion in itself, however, is not determinative of the present appeal. Appellant has submitted evidence tending to prove that his invention has solved the longstanding problem of utilizing the maximum amount of space in standard, 50-ft. boxcars, permitting loading the car with 56 pallets of 48' x 40', whereas prior to the invention, cars of that size could be loaded with only 46 such pallets properly confined. The evidence, comprising two affidavits and a series of exhibits, indicates that

the invention has been commercially successful and that its concept was promptly adapted by a competitor. Recognizing that the inference of obviousness drawn from the prior art disclosures is only prima facie justification for drawing the ultimate legal conclusion that the claimed invention is unpatentable under 35 U.S.C. 103, it is imperative that such secondary considerations also be evaluated in determining the final validity of that legal conclusion. *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966). We emphasize that such is true even where, as here, the claimed invention involves only relatively simple mechanical concepts. As we have said on another occasion: "A patentable invention, within the ambit of 35 U.S.C. 103, may result even if the inventor has, in effect, merely combined features, old in the art, for their known purpose, without producing anything beyond the results inherent in their use." *In re Sponnoble*, 56 CCPA 823, 405 F.2d 578, 160 USPQ 237 (1969).

The first affidavit was by appellant, himself, the manager of the Customer Relations Department of the Equipco division of Unarco Industries, Inc., the assignee of the application. He asserts that 355 railway cars *213 equipped for use with his invention, valued at nearly eight million dollars, were ordered within little more than a year. Included with this affidavit are a series of reproductions of trade journal articles and advertisements tending to support the further assertion made in the affidavit, that the problem of effectively utilizing space was a familiar one. One exhibit is a copy of the advertisement of a competitor, tending to indicate that appellant's concept was adopted by that competitor. The other affidavit is by John Clement, general traffic manager with the Corn Products Co. and apparently a disinterested third party. The affiant states that he has the duty of obtaining all the railroad and other types of cargo equipment necessary for shipping the company's products and that he became interested in the invention immediately upon its being disclosed to him because it appeared to solve problems presented by prior railway car arrangements, allowing use of substantially the entire cargo carrying capacity of the car while permitting truck loading. The affidavit further states that Corn Products had already received 10 cars possessing the proposed arrangement, had ordered 11 more and was negotiating for an additional forty.

The examiner did not consider the affidavits persuasive. That of Clement he characterized as alleging that appellant's arrangement is more versatile than prior arrangements without advancing any factual

support. He regarded appellant's own affidavit as lacking sufficient facts to show that the asserted commercial success resulted from the invention as claimed. The board did not comment on either affidavit in its opinion.

Our own consideration of the affidavits in light of appellant's arguments convinces us that there was a problem in the art due to floor space in the mid-section of cars with side doorways not ordinarily being usable for palletted goods which require securing against transverse and lateral shifting. Moreover, the favorable opinion Clement expressed of the invention and the showing of extensive purchases of equipment for utilizing it indicate that appellant provided an unobvious solution of the problem. The affidavits reveal the solution as involving the arrangement substantially as described in applicant's application. Thus an arrangement is required wherein the relationship of the dimensions of the long and short wall sections and the door openings of the car are such that the pallets may be machine-loaded substantially to its full capacity. We note that these features are brought out fully only in claim 15 which recites that the long and short sections of the side walls are substantially equal to whole multiples of a dimension of a pallet and that the portions of the doorway directly opposite each other have a width equal to a plural multiple of a dimension of a pallet. As to that claim, we find appellant's secondary evidence adequate to rebut the initial inference of obviousness and, accordingly, reverse the decision of the board.

On the other hand, the affidavit showings do not demonstrate that an arrangement lacking any of the characteristics defined in claim 15 solved the previous space-utilization problem or that the commercial success was due to less than all of those features. As to claims 13 and 14, thus, the prima facie case of obviousness made out by the prior art stands un rebutted and the board's decision pertaining thereto must be sustained.

The decision of the board is affirmed as to claims 13 and 14 and reversed as to claim 15.

FN1 Serial No. 566,701, filed July 5, 1966, for "Compartment Arrangement for Railway Cars."

FN2 Patent No. 2,930,332, granted March 29, 1960.

FN3 Patent No. 3,212,458, granted October 19, 1965.

FN4 Patent No. 3,217,664, granted November 16, 1965.

FN5 Patent No. 3,163,130, granted December 29, 1964.

Cust. & Pat.App.

170 U.S.P.Q. 209

END OF DOCUMENT

Appendix 20:

In re Young, 927 F.2d 588, 18 U.S.P.Q.2d 1089 (Fed. Cir. 1991).

United States Court of Appeals,
Federal Circuit.

In re D. Raymond YOUNG and John C. Wride.

No. 90-1368.

March 5, 1991.

The Board of Patent Appeals and Interferences rejected all claims in a patent application disclosing the method and apparatus for generating an acoustic pulse in water, to aid offshore seismic exploration. Applicants appealed. The Court of Appeals, Rader, Circuit Judge, held that the claims were obvious in light of a prior patent for a seismic exploration method.

Affirmed.

West Headnotes

[1] Patents ☞ 16(1)
291k16(1)

Test for obviousness is what combined teachings of references would have suggested to one of ordinary skill in art. 35 U.S.C.A. § 103.

[2] Patents ☞ 16(2)
291k16(2)

Patents are parts of literature of art and are relevant for all they contain. 35 U.S.C.A. § 103.

[3] Patents ☞ 16(3)
291k16(3)

When prior art contains apparently conflicting references, Board of Patent Appeals must weigh each reference for its power to suggest solutions to artisan of ordinary skill; Board must consider all disclosures of prior art to extent that references are in analogous fields of endeavor and thus would have been considered by person of ordinary skill in field of invention. 35 U.S.C.A. § 103.

[4] Patents ☞ 16(2)
291k16(2)

When prior art contains apparently conflicting references, Board of Patent Appeals, in weighing suggestive power of each reference, must consider

degree to which one reference might accurately discredit another. 35 U.S.C.A. § 103.

[5] Patents ☞ 16.33
291k16.33

Board of Patent Appeals and Interferences properly rejected, on grounds of obviousness, all claims in patent application disclosing method and apparatus for generating acoustic pulse in water, to aid offshore seismic exploration; despite being criticized, prior patent for seismic exploration method, which concerned minimizing double oscillation for chemical explosives used in marine seismic exploration, expressly taught spacing limitation in each of claims set forth in application. 35 U.S.C.A. § 103.

Patents ☞ 328(2)
291k328(2)

2,619,186. Mentioned as prior art.

*589 Richard F. Phillips, Jr., Exxon Co., U.S.A., Houston, Tex., argued, for appellants.

Lee E. Barrett, Associate Sol., Arlington, Va., argued, for appellee. With him on the brief was Fred E. McKelvey, Sol.

Before NEWMAN, LOURIE, and RADER, Circuit Judges.

RADER, Circuit Judge.

Raymond Young and his co-inventor John Wride (collectively Young) appeal from the October 31, 1989 and April 18, 1990 decisions of the Board of Patent Appeals and Interferences (Board). These decisions affirmed the final rejection of all claims in their application. The Board held Young's claimed invention obvious under 35 U.S.C. § 103. This court affirms.

BACKGROUND

Young's application discloses a method and apparatus for generating an acoustic pulse in water. Acoustic pulse technology facilitates offshore seismic exploration. The acoustic pulse generates a large gas bubble in the ocean above geological formations on the ocean floor. The rapid expansion and collapse of the gas bubble create a shock wave in the water. The shock wave propagates through the water into the

formations below the ocean bed. As the shock wave passes downward through these formations, each interface between adjoining earth strata reflects a portion of the shock wave. These reflections move upward through the ocean. Hydrophones at the ocean's surface can monitor these reflections. From these monitored reflections, geologists can generate a "seismic section" map which shows the configuration of strata in the ocean bed.

Today's most common sources of seismic shock waves are air guns. These air guns feature a chamber for storing and releasing on command highly compressed air. A high-pressure hose charges the gun with compressed air for rapid firing during a seismic survey.

Acoustic pulse technology suffers from problems with bubble oscillation. Upon release of the compressed air, the bubble undergoes a rapid initial expansion and collapse. Several more expansions and collapses follow the initial collapse, but with diminishing amplitude. Each of these expansion-collapse events creates an additional shock wave. The geological strata reflect each of these additional shock waves. The multiple reflections, in turn, blur the resolution of the seismic section. Most blurring comes from the first oscillation after the initial bubble collapse.

***590** Acoustic pulse technology uses a "primary-to-bubble ratio" to measure susceptibility to oscillation. This ratio compares the shock wave intensity of the initial expansion-collapse to the intensity of the first oscillation. A high ratio means the secondary shock waves are less likely to blur the seismic section.

Young tries to raise the primary-to-bubble ratio above prior art air gun sources by reducing the amplitude of the first oscillation. Young seeks this result by spacing at least three air guns in a characteristic array. The array separates the guns from each other by a critical distance. The distance, D , is at least 1.2 times greater than R , but less than or equal to twice R . R is the maximum radius of the initial air bubble from each gun. [FN*] With this spacing, the bubbles from each gun intersect before any single bubble reaches its maximum radius. This intersection dampens the overall oscillation. Young's independent claims each include a spacing limitation within this range.

FN* Mathematically, D is defined by $1.2 R \leq D \leq 2.0 R$.

Independent claim 1 is illustrative:

A method of producing a seismic pulse in a body of

water, including the steps of:

- (a) disposing in the water a set of at least three air guns, each adapted to produce in the water a gas bubble having maximum radius substantially equal to the quantity R , where the guns are disposed at depths such that each produces, when fired, a bubble of maximum radius R , and the guns are disposed such that each gun is separated from each of the nearest guns thereto in the set by a critical distance, D , where D is substantially equal to $\sqrt{2R}$; and
- (b) firing the air guns substantially simultaneously to produce a seismic pulse in the water.

Young's dependent claims define the number of the guns or their placement relative to each other or to the ocean surface.

The examiner rejected each of the claims as obvious under 35 U.S.C. § 103 in light of five prior art references. The examiner relied primarily on U.S. Patent No. 2,619,186 to Carlisle (the "Carlisle patent" or "Carlisle") to reject Young's claims. Carlisle is the only reference cited by the examiner or Board which suggests the air gun spacing in Young's claims.

Young contested the Board's and the examiner's consideration of Carlisle. Young argued that Carlisle concerns reducing bubble oscillation for chemical explosives, not air guns. Young also argued that an article by Knudsen published six years after Carlisle in the journal *Geophysics* expressly discredits the teachings of Carlisle. W. Knudsen, *Elimination of Secondary Pressure Pulses in Offshore Exploration (A Model Study)*, 23 *Geophysics* No. 3 at 440 (July 1958) (Knudsen). Therefore, Young contended, a person of ordinary skill in the seismic exploration art would not have considered Carlisle when developing an improved seismic array.

The Board rejected Young's arguments. The Board held that the examiner appropriately applied Carlisle notwithstanding the teachings of Knudsen. On appeal, Young asserts as error only the propriety of applying Carlisle as a reference in light of Knudsen's allegedly contrary teachings.

DISCUSSION

This court must decide whether the Board properly affirmed the examiner's rejection over Carlisle. Young has not challenged the other references cited in the examiner's rejection. Further, Young has not argued the merits of any particular claim apart from the others. Therefore, all claims stand or fall together

with representative independent claim 1. See *In re Kaslow*, 707 F.2d 1366, 1376, 217 USPQ 1089, 1096 (Fed.Cir.1983).

The Carlisle patent--"Seismic Exploration Method"--issued on November 25, 1952. Carlisle concerns minimizing bubble oscillation for chemical explosives used in marine seismic exploration. Carlisle controls bubble oscillation by spacing seismic sources to achieve a reduction of the secondary pressure pulse. Carlisle specifically *591 teaches spacing the seismic sources close enough to allow the bubbles to intersect before reaching their maximum radius. Carlisle spaces the bubble centers closer than two maximum bubble radii, or less than "2.0 R" in Young's notation. Carlisle, col. 3, lines 57- 60. Carlisle explains:

[T]he secondary energy normally available from these sources is dissipated by their mutual intersection and tends to eliminate the secondary seismic impulses created when the walls of the bubbles collapse.

Id. at lines 60-64. Thus, Carlisle expressly teaches the spacing limitation in each of Young's claims.

Notwithstanding Carlisle's teachings, Young argues that the Knudsen article discredits Carlisle. Knudsen describes a series of tests which evaluated four proposed techniques for suppressing bubble oscillation. Carlisle was one of the four. Knudsen's article opined that Carlisle yields no appreciable improvement in bubble oscillation suppression. The effective teaching of the Knudsen/Carlisle combination, Young argues, suggests avoidance of the spacing suggested in Carlisle. Therefore, Young would have this court conclude that his use of Carlisle's spacing would not have been obvious.

[1][2] Young misunderstands the effect that Knudsen has on Carlisle. The test for obviousness is what the combined teachings of the references would have suggested to one of ordinary skill in the art. *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 881 (CCPA 1981). Even if tending to discredit Carlisle, Knudsen cannot remove Carlisle from the prior art. Patents are part of the literature of the art and are relevant for all they contain. *In re Lemelson*, 397 F.2d 1006, 1009, 158 USPQ 275, 277 (CCPA 1968). For example, in *In re Etter*, 756 F.2d 852, 859, 225 USPQ 1, 6 (Fed.Cir.), *cert. denied*, 474 U.S. 828, 106 S.Ct. 88, 88 L.Ed.2d 72 (1985), a reference which disclosed obsolete technology remained in the prior art. This court considered the reference for what it disclosed in relation to the claimed invention.

[3][4] When prior art contains apparently conflicting references, the Board must weigh each reference for its power to suggest solutions to an artisan of ordinary skill. The Board must consider all disclosures of the prior art, *In re Lamberti*, 545 F.2d 747, 750, 192 USPQ 278, 280 (CCPA 1976), to the extent that the references are, as here, in analogous fields of endeavor and thus would have been considered by a person of ordinary skill in the field of the invention. The Board, in weighing the suggestive power of each reference, must consider the degree to which one reference might accurately discredit another.

[5] As prior art, the Board correctly weighed Carlisle to determine the patentability of Young's claims. Carlisle expressly teaches both the method and the advantages of Young's claimed spacing. In fact, Carlisle expressly teaches the exact spacing set out as a limitation in Young's claims. Thus, the Board correctly attributed significant weight to Carlisle in its obviousness determination.

In determining what weight to accord to Carlisle as prior art, the Board also appropriately considered Knudsen's discrediting effect. The Board determined that Knudsen did not convincingly discredit Carlisle. Therefore, the Board appropriately concluded that Knudsen would not have led one skilled in the art to reject Carlisle.

Knudsen did not test Carlisle according to its teachings. For instance, Knudsen did not use an explosive charge in modeling Carlisle. Rather, Knudsen tried to simulate Carlisle with a capacitive electrical discharge in a barrel of oil.

Knudsen did not replicate Carlisle's teachings on spacing. Knudsen tried to model Carlisle by separating the seismic sources by one, two and three bubble radii. Knudsen at 42. At the maximum spacing of three bubble radii, the bubbles will not intersect at all. Carlisle specifically requires spacing to permit bubble intersection. Carlisle, col. 4, lines 47-52. At a spacing of one bubble radius, the two bubbles coalesced into one before the initial collapse. Knudsen at 45. If just one bubble is present, the bubble will oscillate as if *592 no second seismic source was present. Carlisle specifically requires spacing to prevent the formation of one bubble. Carlisle, col. 4, lines 34-37. Finally, at the two bubble radii spacing in Knudsen, the bubbles will just barely intersect. Carlisle requires that the bubbles intersect before each bubble achieves its maximum radius.

Carlisle, col. 3, lines 58-60. In sum, Knudsen did not duplicate or appropriately model Carlisle's spacing.

Knudsen's conclusion that Carlisle would "not be effective in eliminating the secondary pressure pulse" also directly contradicts data contained in Knudsen. The Knudsen data point for the two-radii horizontal bubble spacing, although not a completely accurate model of Carlisle, shows a 30% reduction of the secondary pressure pulse. Knudsen at 45, Table 4. This data point represents the only point where Knudsen approximates the spacing shown in Carlisle. At that point, Knudsen confirmed Carlisle's teachings.

The Board found that Knudsen "did not test the Carlisle technique under conditions which are directly comparable to the Carlisle disclosure." Weighing the discrepancies between the Knudsen model and Carlisle's teachings, as well as Knudsen's tendency to confirm Carlisle where the model approximated Carlisle, the Board concluded: "we do not agree that Knudsen discredits Carlisle."

Because Knudsen did not accurately test Carlisle, an artisan of ordinary skill would not have dismissed Carlisle in light of Knudsen as a whole. It is far more likely that the skilled artisan would have afforded little weight to Knudsen itself. The Board did not err in relying on Carlisle and discounting Knudsen.

CONCLUSION

Knudsen is not so credible or persuasive of a contrary teaching that it would have deterred the skilled artisan from using the teachings of Carlisle. The examiner's use of Carlisle in his rejection of Young's claims is not clearly erroneous. The Board's decision affirming the examiner's rejection is therefore

AFFIRMED.

927 F.2d 588, 18 U.S.P.Q.2d 1089

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